ANSI B109.2
Previously Approved
March 16, 2020

Reaffirmation Draft
April 2025

DIAPHRAGM-TYPE
GAS DISPLACEMENT METERS
(500 Cubic Feet Per Hour Capacity and Over)

Secretariat

AGA
American Gas Association

400 North Capitol Street, NW, 4th Floor
Washington, DC 20001
U.S.A.

Catalog No. X62001

First Edition–1973
Second Edition–1986
Third Edition–1992
Fourth Edition–2000
Fifth Edition–2020

American Gas Association
400 North Capitol St., NW, 4th Floor
Washington, DC 20001
U.S.A.

Catalog No. X62001

Approved
AMERICAN NATIONAL STANDARDS INSTITUTE, INC.

TABLE OF CONTENTS

AMERICAN GAS ASSOCIATION (AGA)
NOTICE AND DISCLAIMER

This document was developed through a voluntary consensus standards development process via the American National Standards Institute (ANSI) essential requirements for due process for American National Standards (Edition January 2018). While the American Gas Association (AGA) administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate or verify the accuracy or completeness of any information or the soundness of any judgments contained in this publication.

The AGA disclaims liability for any personal injury, property damages or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from this publication, the use of or reliance on this publication. The AGA also makes no guarantee or warranty as to the accuracy or completeness of any information published herein. The information contained therein is provided on an "as is" basis and AGA makes no representations or warranties including any expressed or implied warranty of merchantability or fitness for a particular purpose.

In issuing and making this document available, the AGA is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is the AGA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Nothing contained in this Standard shall be viewed as an endorsement by ANSI/AGA of any particular manufacturer's product.

The AGA has no power, nor does it undertake, to police or enforce compliance with the contents of this document. Nor does the AGA list, certify, test or inspect products, designs or installations for compliance with this document. Any certification or other statement of compliance with the requirements of this document shall not be attributable to the AGA and is solely the responsibility of the certifier or maker of the statement.

The AGA does not take any position with respect to the validity of any patent rights asserted in connection with any items that are mentioned in or are the subject of this publication, and the AGA disclaims liability for the infringement of any patent resulting from the use of or reliance on it. Users of this publication are expressly advised that determination of the validity of any such patent rights and the risk of infringement of such rights is entirely their own responsibility.

Users of this publication should consult applicable federal, state, and local laws and regulations. The AGA does not, through this publication, provide legal advice for any purpose or intend to urge action that is not in compliance with applicable laws and this publication may not be construed as doing so.

Changes to this document may become necessary from time to time. If changes are believed appropriate by any person or entity, such suggested changes should be communicated to AGA in writing using the form found at the end of the document titled, Form For Proposals on ANSI B109.2 and sent to: American Gas Association, ATTN: Secretariat B109, 400 North Capitol Street, NW, Suite 450, Washington, DC 20001, U.S.A. Suggested changes must include: contact information, including name, address and any corporate affiliation; full name of the document; suggested revisions to the text of the document; the rationale for the suggested revisions; and permission to use the suggested revisions in an amended publication of the document.

PREFACE

This publication represents a basic standard for safe operation, and substantial and durable construction for diaphragm-type gas displacement meters having a gas flow rating of 500 cubic feet per hour capacity (14.16 m^3/h) and over at 0.5-inch water column (125 Pa) differential pressure at base conditions. This work is the result of years of experience, supplemented by extensive research. The standard is designed to help ensure efficient performance and substantial construction of equipment.

It is recognized that during any transition period to the metric system, sizes and dimensions need to be expressed in either the metric system or the inch-pound system or in both. In this document, both systems are used, with the inch-pound units given preference. A soft conversion from existing inch-pound values is shown. Soft conversion implies a change in nomenclature only; in this document, the alternative nomenclature (metric) is shown by using parentheses.

Nothing in this standard is to be considered as in any way indicating a measure of quality beyond compliance with the provisions it contains. It is designed to allow the construction and performance of displacement meters that may exceed the various provisions specified in any respect. In its preparation, recognition was intended to be given to the possibility of improvement through ingenuity of design. As progress takes place, revisions may become necessary. When they are believed desirable, recommendations should be forwarded to the Chairman of ANSI B109 Committee, Operating and Engineering Section, American Gas Association, 400 North Capitol Street, NW, 4th Floor, Washington, DC 20001, U.S.A.

Users of this document should consult applicable federal, state and local regulations. The American Gas Association (AGA) does not, by the publication of this document, intend to present specifications that are not in compliance with applicable rules, and this document may not be construed as doing so.

NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute, Inc. (ANSI) require that action be taken to reaffirm, revise or withdraw this standard no later than five years from the date of publication. When any revisions are deemed advisable, recommendations should be forwarded to the **American Gas Association.** A form is included for that purpose at the end of this standard. Purchasers of American National Standards may receive current information on all standards by writing to the American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036, U.S.A.; by calling (212) 642-4900; by faxing ANSI at (212) 398-0023; or by visiting ANSI's World Wide Web site at http://www.ansi.org. To purchase additional copies of this standard, visit Techstreet's website at http://www.techstreet.com/aga. or go to AGA's web page at https://www.aga.org/news/publications-store/

HISTORY OF THE DEVELOPMENT OF THIS STANDARD

Following approval in 1973 of the Standard for Gas Displacement Meters (Under 500 Cubic Feet per Hour Capacity), ANSI B109.1, a subcommittee was appointed to develop a standard covering gas displacement meters with capacities of 500 cubic feet per hour and over.

Six drafts of the standard were prepared and reviewed by the subcommittee before a final draft was prepared and submitted to American National Standards Committee B109 for its consideration on June 14, 1979. Subsequent to adoption by the committee, the first edition of the standard for gas displacement meters (500 cubic feet per hour capacity and over) was approved as an American National Standard by the American National Standards Institute, Inc., on April 14, 1980.

The second edition was approved on January 9, 1987 and included a new part on auxiliary devices for gas meters, plus an informative Appendix on bar coding.

In the third edition, minor editorial changes and a title correction were made. The third edition was approved on November 12, 1992.

In the fourth edition, several additions/deletions were made to avoid ambiguity, to make it more consistent with industry practices, and to improve upon some requirements. Several minor editorial changes and reaffirmation of the standard was approved by ANSI on April 13, 2000. The document was reaffirmed by ANSI on April 16, 2008 without any change to the document.

During the 2018 review cycle, the standard went through a thorough review and update. The review and reaffirmation period exceeded the five-year period and ANSI withdrew the standard from publication on 4/28/2018. Work on the update continued and the standard was re-introduced with extensive changes and updates. Published as the fifth edition in 2020, the B109.2 standard provides the basis for small commercial and larger diaphragm meters used within the natural gas industry. Additional review and documentation are planned to follow this publication to further update sections, as necessary, to reflect current trends and technological advances pertaining to meters covered by this standard. Substantive changes are shown by a bar [|] in the margin.

ACCREDITED STANDARDS COMMITTEE B109

Patrick Donnelly, Chairman
Ralph Richter, Vice Chairman

Jeffrey Meyers, Administrative Secretary (Non-Voting)

REPRESENTING AMERICAN GAS ASSOCIATION (AGA):

Mike Avery
Daniel Bustamente
Patrick Donnelly
Melissa Fearing
Matthew Holsten
Winston Meyer

REPRESENTING GAS METER MANUFACTURERS:

John Anderson
Robert Bennett
Jon Fickinger
Ron Strong
Chris Wykle

REPRESENTING NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST):

Ralph Richter

REPRESENTING NATIONAL PROPANE GAS ASSOCIATION (NPGA):

Bruce Swiecicki

INDIVIDUAL MEMBER:

Ardis Bartle
Ray Deatherage
Thomas Kegel

SCOPE

This standard applies to diaphragm-type gas displacement meters, designed for revenue measurement of fuel gas, having a flow rating of greater than 500 cubic feet per hour (14.16 m^3/h) capacity at 0.5-inch water column (125 Pa) differential pressure at base conditions.

Part I comprises a list of definitions and terms used throughout the standard.

Part II covers the construction requirements for qualifying new-type meters in the designated flow-rate ranges.

Part III covers the performance requirements for qualifying new-type meters in the designated flow-rate ranges.

Part IV covers the "in-service" performance requirements for diaphragm-type meters in the designated flow-rate ranges.

Part V addresses installation requirements for these meters.

Part VI pertains to auxiliary devices used with meters covered by this standard.

Part VII covers test methods and equipment.

PART I
DEFINITIONS

1.1 **ACCURACY, METER**. The degree to which a meter correctly measures the volume of gas passing through it, determined by comparing the volume registered by the meter with that registered by the prover. (See Appendix D for methods of expressing meter accuracy.)

1.2 **AUTOMATIC INTEGRATORS**

1.2.1 **Recording Type**. This type of automatic integrator is equipped with corrected and uncorrected volume counters and a chart to record the time, pressure or temperature, or combinations thereof.

1.2.2 **Non-Recording Type**. This type of automatic integrator is equipped with corrected and uncorrected volume counters.

1.2.3 **Automatic Integrating Device for Pressure**. An automatic integrating device for pressure is an auxiliary device designed to automatically correct a volume-related input to some predetermined base pressure condition.

1.2.4 **Automatic Integrating Device for Temperature**. Automatic integrating device for temperature is an auxiliary device designed to automatically correct a volume-related input to some predetermined base temperature condition in accordance with Charles' Law.

1.2.5 **Automatic Integrating Devices for Pressure and Temperature**. An automatic integrator device for pressure and temperature is an auxiliary device designed to automatically correct a volume-related input to some predetermined base pressure and base temperature condition in accordance with Boyle's Law and Charles' Law.

1.3 **AUXILIARY DEVICES**. Devices used with a meter to provide an adjustment of the meter reading, to permit obtaining special information, or to transmit information to a remote location.

1.4 **BADGE**. A permanent plate, affixed in a conspicuous place on a meter, containing basic meter information.

1.5 **BASE CONDITIONS**. The standard or base conditions of pressure and temperature for the volumetric measurement of natural gas. As used in this standard 14.73 psi (101.56 kPa) and 60°F (15.6°C) are established as the base pressure and temperature respectively to which all volumes are commonly referred. (Also known as STANDARD CONDITIONS)

1.6 **BOTTLE, CUBIC FOOT**. A specially constructed and calibrated bottle, usually immersion type, complete with an immersion tank containing a light oil of low vapor pressure, with the bottle suspended over the tank by means of a suitable cord and pulley so that the bottle may be immersed in the oil between two graduations, top and bottom. The bottle is constructed so that exactly 1.0 cubic foot of air is displaced when the bottle is immersed between the two marks. The calibration of the bottle must be traceable to the National Institute of Standards and Technology

1.7 **CAPACITY, RATED**. The flow rate in cubic feet per hour of 0.6 specific gravity gas delivered through the meter at an absolute pressure of 14.73 psi (101.5 kPa) and at 60°F (15.6°C) that results in an average differential pressure across the meter connections of 0.5-inch water column (125 Pa).

1.8 **CIRCLE(S), READING**. Graduated index circles with hands that register the accumulated volume of gas passed through the meter.

1.9 **CIRCLE(S), TEST**. A graduated circle provided with a rotating pointer (proving hand) on the meter index, used for testing the meter and for indicating gas flow. Also referred to as index test dial or proving circle.

1.10 **CIRCULAR CHARTS**. A circular chart is a piece of paper, or other suitable material, with graduated lines upon which a pen or stylus draws a record indicating the variables being measured.

1.11 **COMPRESSIBILITY**. Deviation of a real gas from the ideal gas laws relative to changes in pressure and temperature.

1.12 **CONNECTIONS, METER**. The integral parts of the meter designed for attachment to meter swivels, pipe or other piping components.

1.13 **CUBIC FOOT, METERED**. The quantity of gas that occupies 1 cubic foot when under pressure and temperature conditions existing in the meter.

1.14 **CUBIC FOOT, STANDARD**. That quantity of gas at base conditions occupying a volume of 1.0 cubic foot. (See BASE CONDITION)

1.15 **CUBIC METER, STANDARD**. That quantity of gas at base conditions occupying a volume of 1.0 cubic meter. (See BASE CONDITION)

1.16 **DIAPHRAGM**. A semi-flexible material anchored at its periphery, serving as a barrier between the volumetric chambers.

1.17 **FLOW RATE, PILOT**. A minimum flow rate that a meter is required to register with a prescribed accuracy.

1.18 **HUBS, METER**. Same as 1.12, CONNECTIONS, METER.

1.19 **INDEX, METER**. The device that displays the volume of gas that has passed through the meter.

1.20 **INDEX RATE**. The uncorrected flow rate calculated by dividing the registration by time.

1.21 **INDEX TEST DIAL**. See 1.9, CIRCLE(S), TEST.

1.22 **INDEX, CONSTANT PRESSURE COMPENSATING**. An index used in conjunction with a gas meter operated at a constant pressure, other than the contract base pressure, to indicate gas volume corrected to a contract base pressure.

1.23 **INDEX, TEMPERATURE COMPENSATING**. A meter index used to display corrected volume under flowing gas conditions to a base temperature, commonly 60°F (15.6°C).

1.24 **INDICATOR, DEMAND**. A device that indicates on a scale, chart or tape that maximum volume metered during a predetermined period of time.

1.25 **INDICATOR, VOLUME**. A component of an auxiliary device designed to indicate on a scale or chart, or both, the volume of gas passing through a meter in relation to time, temperature, pressure or any combination thereof.

1.26 **INSTRUMENT ADAPTOR PLATE**. An instrument adaptor plate is a mounting surface of suitable material mounted on and driven by a gas displacement meter. The instrument adaptor plate mounts between the meter and instrument and provides the correct instrument drive rotation and speed or displaced volume per revolution with respect to the meter output drive shaft.

1.27 **INSTRUMENT CHART DRIVE**. An instrument chart drive or clock is a timing device used to provide a time base for meter- or clock-driven recorders.

1.28 **INTEGRATING DEVICE**. A mechanism designed to automatically correct a gas volume-related input to some predetermined base conditions.

1.29 **LIFE TEST, ACCELERATED**. A test under controlled conditions simulating long-term operation designed to determine long-term maintenance and performance characteristics within a relatively short period of time.

1.30 **MAOP**. Maximum Allowable Operating Pressure equivalent to manufacturer's maximum working pressure.

1.31 **METER CAPACITY CLASS.** A capacity rated group designation for meters within different ranges of meter capacity. Rated capacity must equal or exceed the class designation, but be less than the next higher meter class.

1.32 **METER, DISPLACEMENT**. A meter that utilizes the principle of alternately filling and emptying compartments of known size and totals the number of times the cycle is accomplished, thereby indicating the volume of gas passing through the meter.

1.33 **METER, GAS**. A device for measuring the volume of flowing gas.

1.34 **METER, NEW**. A meter of all new materials as received from the manufacturer; never used in service.

1.35 **METER, NEW TYPE**. A gas meter sufficiently different in design or materials of construction (such as diaphragm material, cubic feet per tangent revolution, ratio of valve-to-diaphragm area, etc.) so affecting performance as to require qualification as a new-type meter under this standard.

1.36 **MILEAGE**. See 1.58, REGISTRATION.

1.37 =**MULTIPLIER, COMBINED PRESSURE AND TEMPERATURE**. Multiplication factor for correcting the maximum combined pressure and temperature conditions back to base conditions. Combined Pressure and Temperature Multiplier equals:

$$= \frac{520}{T_f + 460} \times \frac{P_g + P_a}{14.73}$$

Where:

T_f = Flowing Gas Temperature, °F
P_g = Meter Gauge Pressure, psig
P_a = Atmospheric Pressure at the Meter Site, psia

1.38 **PERCENT ACCURACY**. The volume indicated by the meter (V_m) divided by the volume indicated by the standard (V_s), taken as a percentage.

$$= \frac{V_m}{V_s} \times 100$$

1.39 **PERCENT REGISTRATION**. See 1.1, ACCURACY, METER and Appendix D. Same as percent accuracy.

1.40 **PRESSURE DIFFERENTIAL**. The difference in pressure between two points in a flowing gas system.

1.41 **PRESSURE DROP**. The loss in pressure between two points in a fluid flow system.

1.42 **PRESSURE SYSTEM.** A pressure system is one that measures pressures above or below atmospheric pressure at any point in a closed system. A pressure-differential device will measure pressure differences within a pressure system or between two pressure systems.

1.43 **PRESSURE, ABSOLUTE**. Atmospheric pressure plus gauge pressure. Abbreviated as psia.

1.44 **PRESSURE, ATMOSPHERIC**. The pressure due to the weight of the atmosphere (air and water vapor) on the Earth's surface. The average absolute atmospheric pressure at sea level has been defined as 14.696 pounds force per square inch.

1.45 **PRESSURE, BASE**. An absolute pressure value to which measured gas volumes are corrected. If a purchase contract applies, the term is referred to as a contract base pressure. See also 1.5 BASE CONDITIONS.

1.46 **PRESSURE, GAUGE**. Pressure measured relative to atmospheric pressure. Abbreviated as psig.

1.47 **PRESSURE, METER**. The pressure in a meter under operating conditions. (Usually considered to be the meter's inlet pressure.)

1.48 **PROVER**. Device for measuring the accuracy of gas meter registration.

1.49 **PROVER, BELL**. Device for measuring the accuracy of gas meter registration. A calibrated cylindrical bell in which a quantity of air is collected over an oil seal.

1.50 **PROVER, CRITICAL FLOW**. See 1.53, SONIC FLOW PROVER.

1.51 **PROVER, LOW PRESSURE FLOW**. An apparatus utilizing an orifice for testing meters at low pressures by passing gas or air through both the orifice and meter and finally discharging it to the atmosphere. The time for a given quantity of gas to pass through the meter compared to the orifice standard time corrected for test conditions provides a measure of meter accuracy.

1.52 **PROVER, PISTON**. A mechanically sealed device that is calibrated to measure the volume of gas delivered to a meter.

1.53 **PROVER, SONIC FLOW**. Also referred to as SONIC NOZZLE PROVER or CRITICAL FLOW PROVER. A device employing either venturi, orifices or sonic nozzles as restrictions that is used for testing meters, usually at elevated pressures, by passing gas or air through both the meter and restriction and finally discharging it at a lower pressure that maintains sonic velocity (critical flow) through the restriction. The time for a given quantity of gas or air to pass through the meter compared to the restriction standard time corrected for test conditions provides a measure of meter accuracy.

1.54 **PROVER, TRANSFER**. A device for determining the accuracy of a meter under test by comparing its reading against the reading obtained from a calibrated reference meter connected in series with the meter under test.

1.55 **READING CIRCLES**. Those circles that indicate the volume of gas passed through the meter and are commonly used for billing purposes. (See 1.8 CIRCLE(S), READING)

1.56 **RECORDER, CHART.** An auxiliary device designed to record variations in pressure, temperature, and/or units of volume by means of a meter- or clock-driven chart.

1.57 **RECORDER, DEMAND**. An instrument that records gas flow rate as a function of time.

1.58 **REGISTRATION**. The indicated volume of gas passed through a meter.

1.59 **REMOTE METER READING DEVICES**. A device for a gas meter that provides or reproduces a reading of the meter index at a point remote from the meter. The reading may be displayed for visual observation, recorded in a portable device or transmitted to a distant point.

1.60 **SEAL**. A device designed to provide evidence of tampering with a meter.

1.61 **STANDARD CONDITIONS**. Same as 1.5, BASE CONDITIONS.

1.62 **STRAPPING**. A method of checking a bell prover by determining the relationship between displaced volume and linear movement of a bell prover by means of measuring scale length, bell circumference and displacement of the sealing liquid.

1.63 **TAPE, STRAPPING**. A metal tape calibrated to give a direct reading of diameter when applied to the circumference of a circular surface.

1.64 **TEMPERATURE SYSTEM**. A temperature system is one that indicates the hotness or coldness of the working medium. A temperature differential device measures temperature differences within a temperature system or between two temperature systems.

1.65 **TEMPERATURE, ABSOLUTE**. That temperature obtained in degrees Rankine by adding 459.67 degrees to a reading of a Fahrenheit thermometer or in degrees Kelvin by adding 273.15 degrees to that of a Celsius thermometer reading.

1.66 **TEMPERATURE, BASE**. A reference temperature to which measured gas volumes are corrected.

1.67 **TEMPERATURE, FLOWING**. The temperature of the gas at flowing conditions.

1.68 **TEMPERATURE, METERING**. The temperature of the gas in a meter at operating conditions. (Defined as the meter's outlet temperature.) See 6.1.6.3.

PART II
CONSTRUCTION REQUIREMENTS
FOR QUALIFYING NEW-TYPE METERS

2.1 SCOPE

This part establishes the construction requirements for qualification of a new-type meter.

2.2 CONNECTION DIMENSIONS

The following standard specifications are included to provide for practical mounting and connecting interchangeability.

2.2.1 **Meter Capacity Class Connections.** Meter connections are established as shown in Table I, Top-Connected Meters, and Table II, Side-Connected Meters. Dimensions for connections listed below as standard, and other commonly used connections, are defined in Appendix A and Appendix B.

TABLE I

TOP-CONNECTED METERS

Meter Capacity Class	Connection Designation		Center-to-Center Dimensions (Dim. A., Fig.1)
	Male Customary (SI)	Female Customary (SI)	
500	45Lt–1½" NPT (DN 40)	1½" NPT (DN 40)	11" (279.4 mm)
900	45Lt–1½" NPT (DN 40)	1½" NPT (DN 40)	11" (279.4 mm)

TABLE II

SIDE-CONNECTED METERS

Meter Capacity Class	Connection Designation		Maximum Meter Base to Connection C (Dim. D., Fig.2)
	Female Customary (SI)	Flanges Face-to-Face (Dim. A. Fig. 2)	
1400	3" NPT (DN 80)	32" (813 mm)	16" (406 mm)
3200	4" NPT (DN 100)	37¾" (959 mm)	18" (457 mm)
3500	4" NPT (DN 100)	37¾" (959 mm)	24" (610 mm)

All pipe threads specified in Tables I and II are in accordance with the “Standard for Pipe Threads (Except Dryseal), General Purpose (Inch),” ANSI/ASME B1.20.1.

2.2.2 **Connection Tolerances.**

2.2.2.1 Top Connections. Meter connections shall conform to the tolerance limits specified in Figures 1 and 2.

It is the intent of these specifications that a suitable sealing medium be used between the meter connections and the swivels or pipes to which they will be attached.

2.2.2.2 Side Connections. Meters with side connections may be constructed either with integral flanges or other appropriate connections. These meters are to be limited in size such that, when flanges are used, their face-to-face dimensions will conform to Table II and the following:

a) The center of the inlet flange shall coincide with the center of the outlet flange within 3/16 inch (4.8 mm). (Dimension B, Figure 3.)

b) The flanges shall be both parallel with each other and perpendicular to an axis through the center of each, to within 2 degrees. (Dimensions C1 and C2, Figure 3.)

The maximum dimension between the center line of the meter connection and the base shall be as shown in Table II. (Dimension D, Figure 3.)

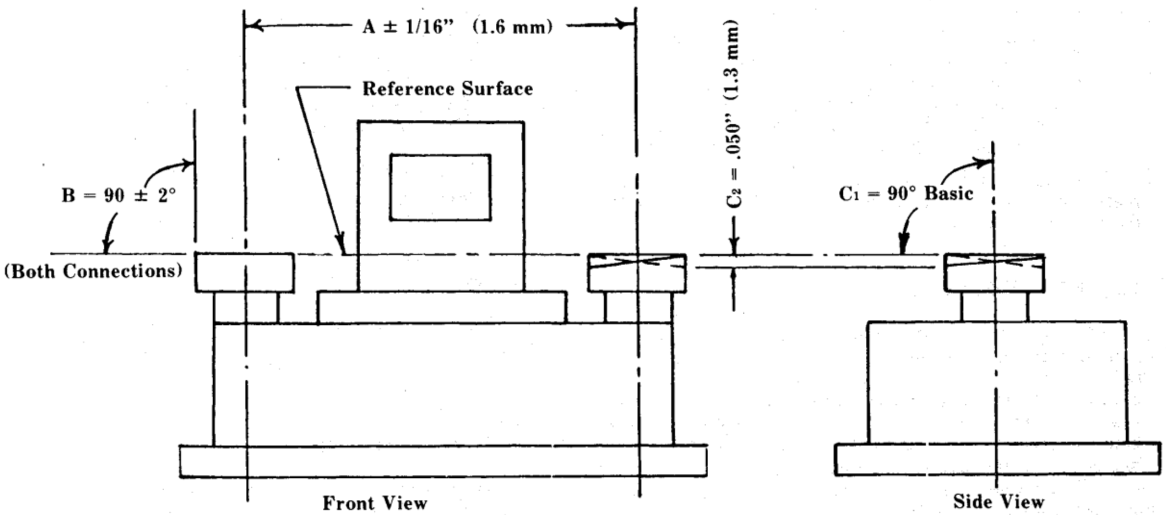


Figure 1. Top connection tolerance (male). See Section 2.2.2.1.

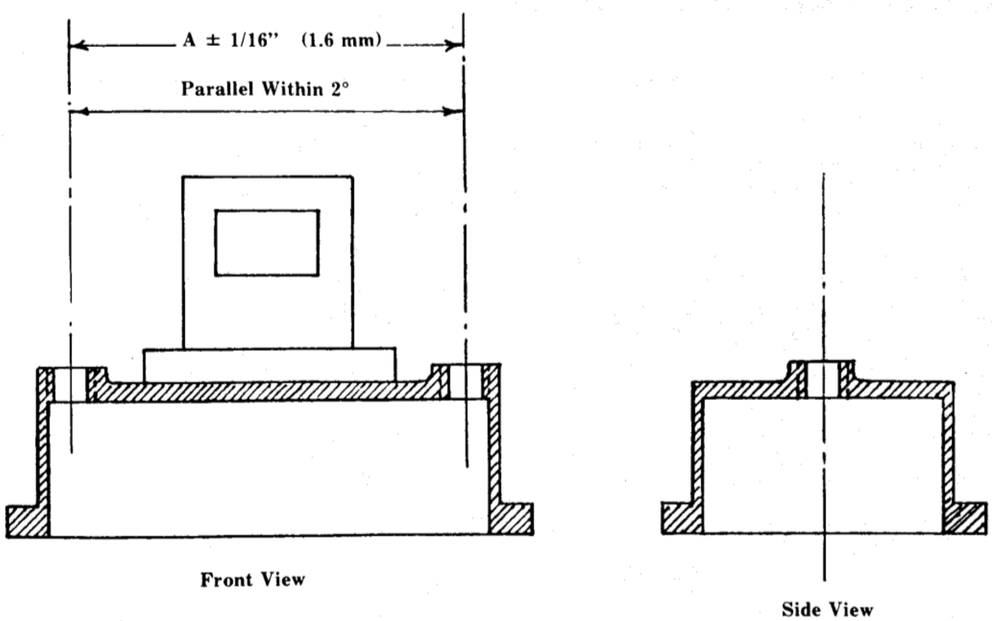


Figure 2. Top connection tolerances (female). See Section 2.2.2.1.

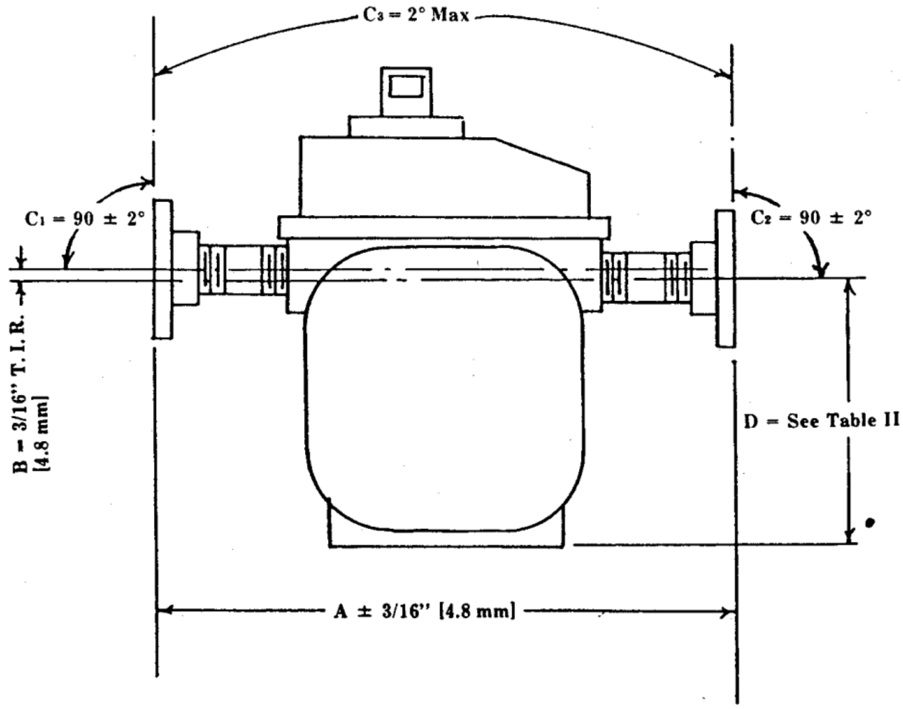


Figure 3. Side connection tolerances

2.3 **METER IDENTIFICATION**

2.3.1 Identification badges shall be readable from the same general position as the index.

2.3.2 **Manufacturer's Identification.**

The manufacturer's product shall contain identification information in a permanent and legible form which requires the information to remain affixed to or incorporated into the meter housing for the service life of the meter with the meter information recoverable by mechanical means through layers of paint, other forms of protective coatings, and corrosion. The information shall be readable from the same general position as the index and positioned in a manner to minimize damage during handling. Numbers shall be of the type shown in Figure 4. The meter serial number shall be at 0.25-inch (6.35 mm) high and shall be visible within an angle of 45 degrees from the perpendicular to the plane of the badge. Acceptable methods of markings can be embossing, etching; stamping and other competing technologies. The following information shall be contained on the badge:

a) Meter Capacity Class.
b) Manufacturer's name or trademark.
c) Meter serial number.
d) Year of manufacture.
e) Maximum Allowable Operating Pressure (MAOP) rating.
f) If the gas meter is a temperature-compensating model, the badge shall be a durable red color and shall state that the meter is "temperature compensating." The use of a badge of red color shall be limited to temperature-compensated meters.
g) Meter capacity at a 0.5-inch (125 Pa) and 2.0 inch (500 Pa) water column pressure differential.

1234567890

1234567890

Figure 4. Suggested styles of numbers and characters on meter badge should follow fonts similar to Century Gothic (top) or Times New Roman (bottom). The intent is to maintain the openness of characters such as”3”, “6” and “9” to prevent confusion with other characters.

2.3.3 **Purchaser's Badge.**

Space shall be provided on the meter for the attachment of a purchaser’s badge and shall be of sufficient size to include the purchaser’s meter identification information.

2.3.4 **Optional Identification.**

If additional meter identification is used (example: bar code, RFID, QR code, etc.), ensure the type and format are amenable to the purchaser. Refer to Appendix F for the preferred bar code standard for meters and auxiliary devices.

2.4 **DIAPHRAGM IDENTIFICATION**

The diaphragm manufacturer's name or trademark, their designation of the type of material and the year of manufacture shall be visible on the diaphragm assembly.

2.5 **INLET IDENTIFICATION**

The inlet connection shall be clearly and permanently identified.

2.6 **PROTECTION OF METERS**

The meter inlet and outlet shall be protected to prevent entrance of foreign materials and to protect the threads during shipment or storage meeting an IP 53 level of protection per IEC 60529, IP Code.

2.7 **SEALING**

For any part of the meter providing access to the meter interior or index, there shall be provision for sealing.

2.8 **METER INDEX**

2.8.1 An indication of the volume units being measured shall appear in a prominent place on the index face. For example, cubic feet, cubic meters, etc.

2.8.2 The index face and markings shall be of contrasting colors to provide for ease of reading. The test circle shall have a white background with black indicators.

2.8.3 The index of a temperature-compensated meter shall indicate in red lettering on a white background that the meter is compensated to a base of 60°F (15.6°C).

2.8.4 Index and markings shall not be adversely affected by environmental conditions.

2.8.5 Meters shall be marked near the output shaft to indicate the direction of rotation and the volume per revolution.

2.8.6 **Pointer-Type Circular Dial Reading Indexes.**

2.8.6.1 Each reading circle shall be divided into 10 equal parts with division marks numbered from “0” to “9” The “0” division mark shall be located at the top of the circle. The reading circles shall be a minimum of 0.6-inch (15.2 mm) in diameter.

2.8.6.2 The index gearing shall provide for adjacent reading hands to rotate in opposite relative directions in a 10-to-1 ratio.

2.8.6.3 The fastest moving reading hand shall be located on the right of the index when viewed from the front of the index.

2.8.6.4 The fastest moving reading hand shall rotate in a clockwise direction and have a value per revolution equal to a multiple of 10 cubic feet (or metric equivalent).

2.8.6.5 The centers of the reading circles shall lie on a straight line or on the arc of a circle or ellipse and follow an uninterrupted reading sequence. Non-reading circles (such as proving or test hands) shall be distinct from reading circles.

2.8.6.6 Each reading circle shall be appropriately marked to indicate the number of volume units measured per complete revolution of the reading hand and shall be provided with an arrow indicating the direction of rotation of the reading hand.

2.8.6.7 On non-reading circles with “proving hand” or “test hands,” the volume per revolution shall be clearly indicated. The circle shall have 10 equally spaced divisions and an arrow shall be provided to show the direction of rotation. No numbers shall appear on subdivisions.

2.8.7 **Direct Reading Indexes (Digital Type).**

2.8.7.1 The digits of the counter shall be arranged to appear in a horizontal straight line that can be viewed easily through a cutout in the index face. The advance by one unit of a figure of any order must take place completely while the figure of an order immediately below passes through the last tenth of its course.

2.8.7.2 A permanent decimal point, zeroes or a multiplier shall appear on the index face to clearly indicate total volume units appearing on the counter. Example: Last digit on right side of counter indicates hundreds of volume units. Two permanent zeroes (“00”) or a multiplier of “× 100” will be shown in the line with and to the right side of the last digit to indicate total units.

2.8.7.3 An appropriate test hand or unit wheel shall be provided for proving a meter with a direct reading index and should meet the general requirements of 2.8.6.7

2.8.8 **Constant-Pressure-Compensating Index.**

2.8.8.1 The design of pressure-compensated pointer-type and direct-reading indexes shall comply with 2.8.6 and 2.8.7, except as noted below.

2.8.8.2 All compensating indexes shall be equipped with a test circle designed to indicate the uncorrected volume and shall comply with 2.8.2.

2.8.8.3 The face of a pressure-compensating index shall be red with markings of a contrasting color. The index face shall be permanently marked with the actual gear ratio (G.R.) in fractional form and nominal pressure for which the index is designed, for example:

$$\text{G.R.} = \frac{85}{12} \text{ at 10 psi gauge nominal}$$

or

$$\text{G.R.} = \frac{27}{5} \text{ at 69 Pa, gauge, nominal}$$

2.8.8.4 Gear Ratios. The gear train between the test circle and the least significant reading position (volume circle or wheel) shall be designed to have a ratio as near as possible to, but not to exceed ±0.75% of the theoretical ratio required to correct the indicated volume in accordance with Boyle's Law. Standard constant-pressure English unit indexes shall be manufactured to compensate, as nearly as practical, for the following conditions:

a) 14.4 psia (99.3 kPa) atmospheric absolute pressure.
b) 14.73 psia (101.6 kPa) base absolute pressure.
c) 2, 5, 10, 15, 20, 25, 30 or 50 psig (14, 34, 69, 103, 138, 172, 207 or 345 kPa, respectively) metering gauge pressure.

2.8.8.5 Non-Standard Conditions. Each manufacturer should provide a set of adjusted gas delivered pressure tables for each of their indexes, taking into account the following factors:

a) The difference between the theoretical and actual gear ratio.
b) Average atmospheric pressure in a minimum of 500 ft. (150 m) increments for the elevations from 0 to 5,000 ft. (1,500 m) above sea level.
c) Base absolute pressures of 14.65 psia (101.0 kPa), and 14.73 psia (101.6 kPa) and gauge pressures of ¼ psi (1.73 kPa), and ½ psi (3.45 kPa) above atmospheric.

2.8.8.6 The index dial of temperature-compensated meters with a pressure-compensating index shall indicate in a contrasting color that the meter is temperature-compensated to a given base temperature, such as 60°F (15.6°C), for example: "Cubic feet pressure-compensated to 10 psi (69 kPa) gauge nominal and temperature-compensated to 60°F (15.6°C)."

2.9 CORROSION AND CHEMICAL RESISTANCE OF INTERNAL PARTS

All materials of the meter and component parts shall be suitable for the intended use and shall be chemically resistant to constituents normally found in natural, manufactured and liquefied petroleum (LP) gases.

2.10 CORROSION AND CHEMICAL RESISTANCE OF EXTERNAL PARTS

The meter case and external components shall be made of or protected by materials resistant to attack by the atmosphere, weather or sunlight and agents used in meter cleaning and repair. Meter exteriors shall be capable of meeting or exceeding the following tests:

2.10.1 Accelerated Weathering Test.

Samples of the meter case or other specific external parts of the meter that are to be tested shall be prepared and protected using exactly the same methods and material employed in manufacturing the meters. Samples shall be exposed to the following weathering tests, with reference to ASTM D822, ASTM D6695 (Daylight Filter), or ASTM D4587 (UVA-340) for 2,000 hours. The exposure cycle shall consist of the periods of ultraviolet light radiation and fresh water spray shown in Table III. Following this 2,000 hour test, there shall be no appreciable progressive corrosion, or electrolytic action, or any appreciable discoloration or deleterious reaction.

TABLE III
EXPOSURE CYCLE

Portion of Exposure Cycle	Time Period
Direct ultraviolet radiation Light Only:	102 minutes
Fresh water spray Light and spray:	18 minutes
Total Length of Each Exposure Cycle	120 minutes

2.10.2 **Salt Spray Test.**
Samples as in 2.10.1 shall be mounted in the salt spray chamber in their normal operating position. They shall be subjected to a 1,000-hour salt spray test in accordance with the ASTM Method B117-1973, "Salt Spray (Fog) Testing." At the conclusion of the test, the coating will meet or exceed the following acceptance criteria:

a) Ferrous based materials shall be evaluated using ASTM D-610 and have a score of Grade 4 or greater.
b) Non-ferrous metal materials shall be evaluated using ASTM D-714 and exhibit blister size No. 4 or greater with no more than a medium density.

2.10.3 **Chemical Resistance Test (for meter index window).**
The meter index window shall demonstrate resistance to chemicals recommended by the manufacturers and used in cleaning meters.

Method of Test

The window shall be immersed in the cleaning agent for 30 minutes, without showing any discoloration or harmful effects.

2.11 **METER INDEX WINDOW IMPACT RESISTANCE**
The index window shall resist impact.

Method of Test

With the index assembled on the meter, the window shall withstand a perpendicular impact of a 0.875-inch (22 mm) solid steel ball dropped from a height of 15 inches (381 mm).

2.12 **METER INDEX WINDOW CLEARNESS TEST**
Under normal installation conditions, there shall be no appreciable distortion or loss of clarity of the index markings caused by the window material.

2.13 **TEMPERATURE AND THERMAL SHOCK RESISTANCE**
A meter shall be capable of operating within ambient temperature and flowing gas temperature limits of -30°F and 120°F (-34.4°C and 49°C) and, following conduct of the test specified in 2.13.2, the meters shall comply with the accuracy specifications in 3.3.1 and 3.3.2. and the pressure test requirements specified in 3.5.

2.13.1 **Temperature Resistance.**

The meter case only shall withstand the following high temperature test.

Method of Test

The meter case shall be exposed to 360°F (182°C) for a period of one hour. After the test the meter casing shall be allowed to return to room temperature and shall comply with the pressure requirements specified in 3.5.

2.13.2 **Thermal Shock Resistance.**

The assembled meter shall withstand the following thermal shock test.

Method of Test

The assembled meter shall be heated in 140°F (60°C) water for 1 hour and then plunged into water at a temperature of 40°F (4.4°C). The assembled meter shall then be cooled to 20°F (-6.7°C) for 1 hour and then plunged into water at a temperature of 120°F (49°C).

2.14 **STRENGTH OF METER CONNECTIONS**

The meter connections shall be constructed to provide adequate strength in connecting the meter to related piping systems.

Method of Test

Tests for determining the strength of meter connections shall be performed with a device constructed to:

a) Provide a lever arm of predetermined length to which a force can be applied in a perpendicular plane for performing torsional and bending moment tests.
b) Provide a pressure-tight connection at the meter connection.
c) Provide a pressure tap for connecting a manometer or pressure gauge.

With the meter subjected to an internal pressure of 1.5 times the MAOP or 10 psig (69 kPa) gauge, whichever is greater, the inlet and outlet connections shall be individually subjected to the bending moment and the torsion shown in Table IV for a period of one minute. There shall be no leakage, and meter accuracy shall not be adversely affected by these tests (see 3.3.1 and 3.3.2).

TABLE IV

BENDING MOMENTS AND TORSION REQUIREMENTS

Meter Connection		Bending Moment		Torsion	
Size, Inches	Thread	Pound-feet	Newton-meters	Pound-feet	Newton-meters
1½	M.C.	200	270	300	405
1½	NPT	500	680	300	405
2	NPT	1000	1355	350	475
3	NPT	3000	4065	500	680
4	NPT	8000	10845	600	815

M.C. = Meter Connection
NPT = “National Pipe Thread, Standard for Pipe Threads (Except Dryseal),” ANSI B2.1.

PART III
PERFORMANCE REQUIREMENTS FOR QUALIFYING NEW-TYPE METERS

3.1 **SCOPE**

This part establishes the performance requirements for qualification of a new-type meter.

3.2 **METER CAPACITY CLASSES**

The gas capacity at 0.5-inch water column (125 Pa) differential pressure in terms of a 0.6 specific gravity gas under specified conditions determines the capacity class for a given type of meter. (See Table V). Class 500 designates meter types whose gas capacities are 500 ft^3/h (14.2 m^3/h) or more but less than 900 ft^3/h (25.5 m^3/h). Ranges for other classes are similarly determined. [Example: a meter having a capacity of 1,400 ft^3/h (39.6m^3/h) or more, but less than 2,300 ft^3/h (65.1 m^3/h), falls into Class 1400.]

TABLE V

METER CAPACITY CLASS by RATED CAPACITY (ft^3/h)

Meter Capacity Class	Minimum Capacity		Maximum Capacity	
	(ft^3/h)	(m^3/h)	(ft^3/h)	(m^3/h)
500	500	14.2	899	25.5
900	900	25.5	1399	39.6
1400	1400	39.6	2299	65.1
2300	2300	65.1	3499	99.1
3500	3500	99.1	5599	158.5

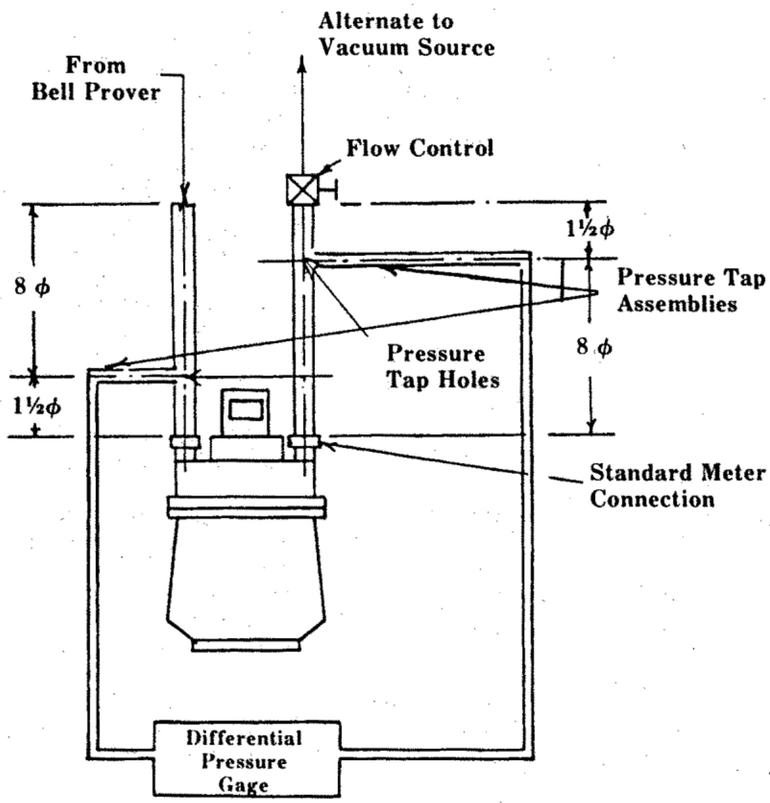
3.2.1 **Determination of Meter Capacity.**

The capacity shall be determined with a bell prover using air, and test data shall be referred to standard conditions: i.e., 60°F (15.6°C) and 14.73 psi (101.6 kPa) absolute referred to a 0.6 specific gravity. The capacity is obtained by rounding to the nearest multiple of 5 ft^3/h. The average readings of 10 randomly chosen production-type meters representing a particular meter model.

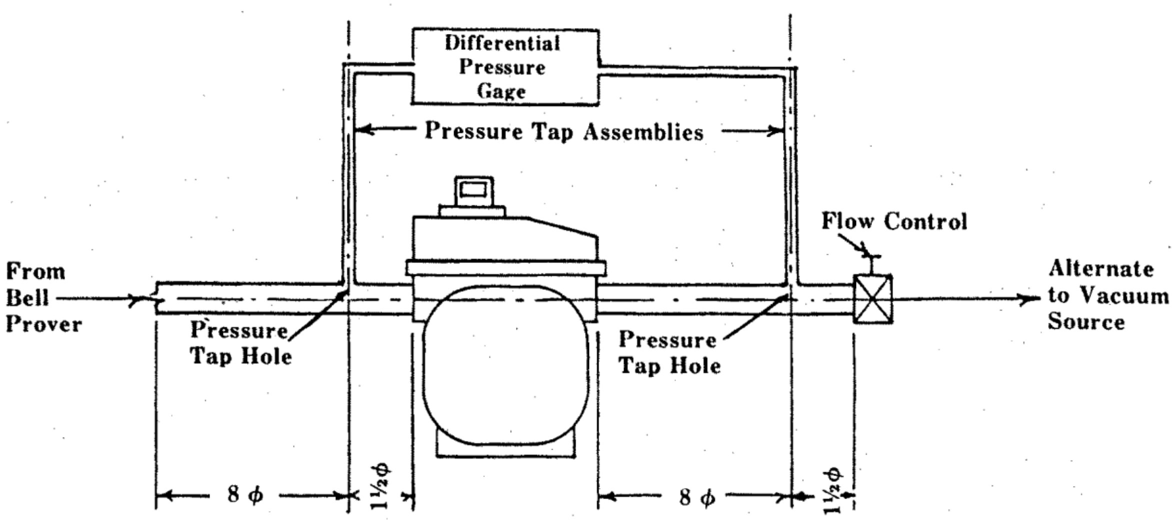
3.2.1.1 **Test Conditions**.

a) Bell prover operating on air at a minimum of 1.5 inches water column (375 Pa) gauge.
b) Differential Pressure Gauge. A precision manometer accurate to 0.01-inch water column (2.5 Pa) gauge, and equipped with a snubber to dampen pulsations to a maximum of 0.02-inch water column (5 Pa).
c) Test System Piping. The piping of the pressure tap assemblies shall be Schedule 40 pipe of the same nominal size as the meter connections. Pressure tap assemblies shall be as shown in Figure 5. The pressure tap holes shall not be less than 1/8 inch (3 mm) nor more than 1/4 inch (6 mm) in diameter and shall be drilled perpendicularly to the wall, and the center line of the hole shall intersect the center line of the pipe. The intersection of the pressure hole and the inside surface of the pressure tap assembly shall be free from burrs and preferably slightly rounded. No pressure tap connection shall be used that distorts the inside surface of the pressure tap assembly or that projects into the passage.
d) To determine the capacity, the meter on test shall comply with the accuracy specifications of 3.3.1. The connection sizes for meters on qualification test are as indicated in 2.2.1, Tables I and II.

Pressure Tap Location for Top-Connected Meters



Pressure Tap Location for Side-Connected Meters



φ = Nominal Pipe Size of Meter Connection

Figure 5. Test apparatus and arrangement for determining meter capacity class.

3.2.1.2 **Meter Capacity Class Test.**

With the meter connected to the test system and the bell prover supplying test air, the control valve shall be adjusted until exactly 0.5-inch water column (125 Pa) differential is read on the differential pressure gauge (any small fluctuations should be averaged into the reading).

With a stopwatch, the bell shall be timed for a unit volume displacement as indicated by the prover scale to determine the observed air flow rate through the meter. The proving bell temperature and the barometric pressure shall be noted at the time of the test.

3.2.1.3 **Meter Capacity Class Calculations**.

From the time interval and the volume measured, the hourly rate shall be calculated. This will be the observed air capacity of the meter.

$$C_o = \frac{3600(v)}{t}$$

where:

v = corrected volume
t = time interval, seconds
C_o = observed air capacity of the meter, ft^3/h (m^3/h)

and

$$v = \left(V_{\text{prover}} \times \frac{P_{\text{prover}}}{P_{\text{meter}}} \times \frac{T_{\text{meter}}}{T_{\text{prover}}}\right)$$

Corrections for barometric pressure, temperature and specific gravity shall be made as follows:

$$C_g = C_o \left(\frac{1}{0.60} \times \frac{P_m}{14.73} \times \frac{520}{T_m}\right)^{0.5}$$

where:

P_m = meter inlet pressure, absolute, (psia)
C_g = gas capacity corrected for pressure, temperature and 0.60 specific gravity gas
T_m = meter outlet air temperature, absolute (°R)

Observations should be made on a statistically reliable sample of a given type of meter to average manufacturing variations to determine minimum gas capacity (C_g) and ensure proper capacity class designation.

3.2.2 Although meter capacity class designations are based on capacity measurements, service capacity limitations are neither suggested nor implied. For calculating recommended meter capacities at specific service conditions, see Appendix C.

3.3 **ACCURACY OF METERS**

A meter shall measure and register gas accurately within the range of flow rates for which it was designed.

3.3.1 **Initial Accuracy.**

The initial accuracy, after adjusting the meter to 100 ±0.2% registration at approximate flow rates of 20% to 35% and 100% of its rated capacity, shall be within the accuracy requirements for the meter capacity class as specified in Table VI.

Method of Test

The accuracy of a meter under test, either for pilot flow or test flows, shall be determined as follows:

a) The meter shall be connected in series with a proving standard having sufficient flow rate and pressure capacity.
b) The test flow accuracy shall be determined by comparing the registered volume of the proving standard with the registered volume of the meter under test. Correction for pressure and temperature differentials shall be made when applicable.

Pilot flow accuracy can be determined as described above for the operating flows or by the use of a calibrated orifice having the required flow rate with a constant pressure input. Timing of a registered volume through the meter and comparing this flow rate with the calibrated orifice's flow rate shall determine the pilot flow accuracy. Prior to initiation of accuracy tests, meter and piping system shall be tested for tightness and all leaks eliminated.

3.3.2 **Sustained Accuracy.**

After being subjected to the accelerated life test described in 3.3.3, the meter accuracy shall be within:

a. 10.0 percentage points of its initial accuracy at pilot flow rate as shown in Table VI.
b. 2.0 percentage points of its initial accuracy at test flow rates as shown in Table VI.

Method of Test

The accuracy of a meter under test, either for pilot flow or test flows, shall be determined as described in 3.3.1.

TABLE VI
ALLOWABLE VARIANCES FROM CALIBRATED ACCURACY AT VARIOUS TEST FLOW RATES

Meter Capacity Class Designation	Approximate Flow rate (AIR)							
	Pilot Flow Rate		Test Flow Rates					
	ft^3/h	m^3/h	ft^3/h	m^3/h	ft^3/h	m^3/h	ft^3/h	m^3/h
500	1.0	0.028	50	1.4	100	2.8	400	11.3
900	1.8	0.051	90	2.5	180	5.1	720	20.4
1400	2.8	0.079	140	4.0	280	7.9	1120	31.7
2300	4.6	0.130	230	6.5	460	13.0	1840	52.1
3500	7.0	0.198	350	9.9	700	19.8	2850	80.7
Accuracy BEFORE accelerated life tests	±10.0%		±1.0%		±1.0%		±1.0%	
Accuracy AFTER accelerated life tests*	±10.0%		±2.0%		±2.0%		±2.0%	

* When compared with actual accuracy before accelerated life tests.

3.3.3 **Accelerated Life Test.**

To determine the ability of a displacement meter to measure gas accurately for relatively long service periods, it shall be subjected to an accelerated life test. To comply with this provision, the meter shall continue to operate and register for the entire period of the accelerated test.

NOTE: After the accelerated life test, the meter shall be tested and shall comply with the sustained accuracy specifications of 3.3.2.

Method of Test

Meters shall be leak- and flow-tested and calibrated before being placed on the test rack. Meters shall be calibrated to an accuracy of 100% ±0.2% in accordance with 7.5.5.4.

Meters shall be installed on a test rack, using the type of gas for which the meter is intended. Flow rate through meters shall be maintained between 180% and 220% of rated capacity. After total meter index registration is equal to 8,000 times the 0.5-inch water column (125 Pa) or 4,000 times the 2.0 inches water column (500 Pa) rated hourly capacity, the accuracy of the meter shall be within the limits specified in 3.3.2.

3.4 **METER CASE PRESSURE TEST**

The meter case shall be able to withstand a burst test using an internal pressure equal to at least four times MAOP of the meter.

3.5 **PRESSURE AND LEAK TESTS**

This test requirement shall also apply to all newly manufactured meters.

3.5.1 Each new-type meter shall be tested to establish that it is able to withstand an internal pressure in excess of that to which it may be subjected in actual service. A shell (or case) pressure test shall be performed on all meters to a minimum pressure of 10 psig or at 1.5 times the MAOP, whichever is greater, for cast steel, cast aluminum and wrought aluminum shells, and at 2.0 times MAOP for cast and ductile iron shells. (Reference Section VIII, ASME *Boiler and Pressure Vessel Code*).

3.5.2 Each new-type meter shall be given a pressure leak test while submerged in water, or a test equivalent in sensitivity, to determine that it is free from leakage. During the test, the meter shall be slowly pressurized [not exceeding 5 psi per second (34 kPa)] with a gas, from 0 psig to at least 1.25 times the MAOP.

Method of Test

The meter shall be sealed and submerged in water prior to pressurization. During pressurization and for at least 1 minute after maximum pressure has been reached, there shall be no leakage.

3.6 **NOISE AND VIBRATION**

Meters shall be essentially free of noise and vibration.

PART IV
IN-SERVICE PERFORMANCE

4.1 **SCOPE**

This part establishes in-service performance standards for gas meters used in revenue measurement of fuel gas. Test conditions are first outlined that are designed to reasonably ensure compliance with the in-service performance programs set forth in this part.

4.2 **TEST CONDITIONS**

4.2.1 **General.**

New meters, repaired meters and in-service meters shall be inspected and tested, and appropriate action taken to provide assurance that in-service meters conform to the accuracy specifications of this part.

4.2.2 **Test of New or Repaired Meters.**

Meters shall be inspected and tested in meter shop, on site, or in other test facility and appropriate action shall be taken to ensure that the meters conform to the limits set forth in 4.2.5.

4.2.3 **Test Equipment.**

All meters shall be tested using appropriate test equipment and methods established in Part VII.

4.2.4 **Test Flow Rates.**

Meters shall be tested on air at one or more rates of flow as needed to ascertain their accuracy. When two rates are used, the low flow rate shall be equivalent to 20% to 40% of the applicable meter capacity and the high flow rate shall be equivalent to 80% to 120% of the applicable meter capacity. These tests shall be conducted on the basis of either the 0.5- or 2-inches water column (125 or 500 Pa) capacity of the meter as appropriate for its use.

4.2.5 **Adjustment Limits.**

Before being placed in service, meters shall be adjusted to an accuracy of 100% within limits of +1% and –2% at low flow (20% to 40% of capacity) and a high flow rate (80% to 120%). The numerical difference between the test values for those two rates should not exceed one percentage point.

4.3 **IN-SERVICE PERFORMANCE PROGRAMS**

4.3.1 **Objectives.**

The primary purpose of the in-service performance testing is to provide service-life information on which the user may base a meter utilization program. The testing and maintenance procedures, meter design and the level of accuracy specified must be such that a realistic balance exists between the benefits realized from high accuracy levels and the cost of achieving these levels. Any program established should be reviewed periodically with a view toward improvement in light of the current state of the art.

4.3.2 **Test Programs.**

If meter quantities are adequate, statistical sampling and variable interval plans can provide for differences in meters and operating conditions and encourage improvements in meter design and meter maintenance programs. Statistical sampling programs use statistical analysis techniques to monitor the accuracy of meters in service. Variable interval plans also rely on meter test data but use different methods to accomplish the same purpose.

4.3.2.1 **Statistical Sampling**. A statistical sampling program for testing gas meters should conform to the general provisions set forth in this section and shall be based on accepted principles of statistical sampling.

Meters shall be divided into homogeneous groups such as year set, manufacturer, case type, diaphragm material, etc. However, any group of meters may be combined with another group with similar operating characteristics to provide an adequate sample size for analysis and control. Meters in any given group may be further subdivided according to location, age or other factors that may be disclosed by test data to have an effect on the performance of the meters. Subsequently, groupings may be modified or combined as justified by the performance records.

A sample shall be taken periodically from each group. The sample taken shall be of sufficient size to demonstrate with reasonable assurance the condition of the group from which the sample is drawn. Meters removed from service on a routine basis may meet the sample requirements; however, if a larger sample is required for a particular group, an additional random sample shall be removed from service.

The sampling program shall be designed to accomplish the objectives set forth in 4.3.1, and it should include a statistically acceptable method for determining group performance and specify the degree of confidence to be applied to the test results of the sample meters.

An example of the sampling program is one that will, nine times out of ten, determine that as many as 75% of the meters in a meter control group are within the percent accuracy limits of 98% and 102% for low flow (check) rate with no more than 12.5% of the meters exceeding 102% accuracy. If a group of meters does not meet the performance criteria as measured by the sample test results, then corrective action shall be taken.

The corrective action may consist either of a selective removal program to raise the accuracy performance of the group to acceptable standards or the removal of the entire group from service. The rate of removal could be such that required corrective action is completed within four years.

4.3.2.2 **Variable Interval**. A variable plan for testing gas meters should conform to the general provisions set forth in this section.

As stated above, meters shall be divided into homogeneous groups such as year set, manufacturer, case type, diaphragm material, etc.; however, any group of meters may be combined with another group with similar operating characteristics to provide an adequate sample size for analysis and control. Meters in any given group may be further subdivided according to location, age or other factors that may be disclosed by test data to have an effect on the performance of meters. Subsequently, groupings may be modified or combined as justified by the performance records.

The number of meters to be tested from each group during the current year shall be a percentage of the total original group and be dependent upon the results of the in-service performance tests made during the preceding year, or years, up to a maximum of three. The number or percentage of meters to be tested in each group is a function of the percentage of meters found outside the acceptable percent accuracy limits of 98% and 102% for check rate. The relationship used to determine the number of meters to be tested shall be designed to meet the objectives set forth in section 4.3.1 and shall provide for increasing the number of meters tested with increases in the percentage of meters outside the acceptable limits.

An example of variable interval is one in which the formula provides for a test rate of 25% when all meters are within the acceptable percentage accuracy limits of 98% and 102% for check rate. The test rate should then increase linearly to 8% when 70% of the meters tested in each group are found to be within the acceptable accuracy limits of 98% and 102% for check rate. The plan should also provide for removal rate of 25% when the percentage of meters within the acceptable limits is less than 60%. The minimum number of meters to be removed from each group should be 200 meters or 10% of the total group, whichever is the lesser.

4.3.2.3 **Periodic Interval**. Periodic interval plans provide for a fixed interval test. The plans may fail to recognize the difference in accuracy characteristics of various types of meters due to technical advances in meter design and construction.

In order to provide incentives for modernization of meter maintenance programs, periodic interval plans should be established based on historical test data for the particular utility.

To initiate this program, a utility may elect to adopt a 10-year test period. As the historical test data are developed, a test period greater than 10 years can be adopted when the number of meters in the 98% to 102% registration category exceeds 70% of the total number of meters being tested. The periodic interval program should be reviewed periodically and modified when necessary to keep pace with modern technology and alternative meter test programs.

4.3.2.4 **Registration**. Meter test programs may be established based on "mileage," or the amount of gas passed through the meters. These programs should be reviewed periodically and revised when necessary to maintain performance levels equivalent to other accepted plans.

4.4 RECORDS

Records of meter tests shall be maintained. For programs using meter groups, the records shall show the number of meters initially installed in each group, subsequent modifications or combinations of groups, and at the end of each year for each group, the number remaining in service, size of test sample, test results and corrective action taken.

PART V
METER INSTALLATION

5.1 **SCOPE**

This part establishes installation requirements for meters used in revenue measurement of fuel gas.

5.2 **GENERAL**

The customer or his agent should confer with the supplier of gas service as one of the first steps in planning a new gas meter installation or a major alteration to an existing one. Normally, the supplier shall determine the location, type and size of metering equipment to be installed.

The supplier of gas service shall have available for customers, architects and contractors, copies of supplier's rules, specifications and requirements pertaining to meter installations. Meter installations shall conform to the safety requirements of the supplier and applicable codes.

5.3 **LOCATION**

a) Gas meters shall be located in ventilated spaces readily accessible for examination, reading, replacement or necessary maintenance.
b) Gas meters shall not be located where they will be subjected to damage, such as adjacent to a driveway, under a fire escape, in public passages, halls, coal bins, or where they will be subjected to excessive corrosion or vibration. Electrical separation shall be maintained between cathodic-protected and noncathodic-protected piping.
c) Gas meters shall be located at least 3 feet from known sources of ignition or air intakes.
d) Gas meters shall not be located where they will be subjected to extreme temperatures or sudden changes in temperature. Meter manufacturers shall furnish information regarding safe temperature limits.

5.4 **INSTALLATION**

5.4.1 **Bypass Piping.** It may be desirable to install a secure valve bypass around the meter. This arrangement will allow meter maintenance as required without interrupting service. The installation of a blow-down valve on the meter piping may further facilitate removal or maintenance.

5.4.2 **Instrumentation.** When instrumentation is to be installed to bring metered gas volume to base conditions, temperature wells, pressure taps and other auxiliary connections should be installed in accordance with manufacturer's recommendations.

5.4.3 **Pressurizing and Depressurizing the System.** In order to prevent internal damage to the meter, the system should be pressurized or depressurized slowly. Generally, the gauge pressure change should not exceed 5 psi (34 kPa) per second. Pressurization may be accomplished by the installation of a small needle valve on a bypass around the main shut-off valve.

5.4.4 **Meter Shut Off.** A means shall be provided between the main and the meter to shut off the gas.

5.4.5 **Meter Support.** Meters shall be secured in a proper position and installed in such a manner as to avoid stress upon the connecting piping or the meters.

5.4.6 **Meter Sizing.** Meters shall be sized to measure the expected load. The diversity of the total connected load and the maximum operating capacity should be considered (see 3.3).

5.4.7 **Spacing of Meters.** When two or more meters are grouped, they shall be spaced so that installation, maintenance, testing and removal of an individual meter can be accomplished without disturbing the adjacent meter(s).

5.4.8 **Identification.** When two or more meters are installed at one building, the piping, other than the meters, shall at all times be legibly marked to indicate the customer or facility being metered.

5.5 **ON-SITE INSPECTION**

A general inspection of the metering facility serving the customer shall be made when a meter is installed, removed or tested.

5.6 **SPECIAL SERVICE REQUIREMENTS**

Before a customer installs equipment or facilities that require service at other than the supplier's standard conditions, he shall provide the supplier with all necessary information for consideration of the application. Attention should be given to conditions such as pulsations, surges, other pressure fluctuations and temperature variations that might affect metering and control equipment. Some provision for maintaining continuity of supply (such as the use of a meter bypass, etc.) should be considered when a planned interruption would cause undue hardship to the customer or supplier.

PART VI
AUXILIARY DEVICES FOR GAS METERS

6.1 SCOPE

This part includes the standard requirements, approval tests, and test methods for auxiliary devices that are commonly used with gas displacement meters. Included in this section are:

a) Temperature, pressure and volume recording devices
b) Temperature, pressure and volume integrating devices
c) Load demand devices
d) Remote reading units including any associated actuating device
e) Other miscellaneous associated equipment

The primary objectives are to:

a) Provide a workable and realistic standard, and acceptance criteria for new types of auxiliary devices.
b) Provide guidelines for inspection and testing as well as establish performance standards for new devices.
c) Provide guidelines for inspection, testing and maintenance as well as establish performance standards for in-service devices.
d) Specify realistic test standards.

6.1.1 **Acceptable Auxiliary Devices.** Auxiliary devices, in order to be recognized as an acceptable type, shall conform to requirements specified below, which are intended to determine their reliability and acceptable accuracy.

6.1.2 **Adequacy of Test Equipment.** Where applicable and feasible, tests for determining the acceptability of the types of auxiliary devices under these specifications should be made using reference standards or instruments of an order of accuracy at least three times greater than specified for the device being tested. The tests shall be conducted or directed by personnel who have a thorough practical and theoretical knowledge of meters, instruments and related auxiliary devices.

6.1.3 **Inspection and Testing.**

6.1.3.1 **New Devices**. New auxiliary devices should be inspected and tested in a shop or laboratory before being placed in service. The tests should be performed using test equipment as prescribed in 6.1.2.

6.1.3.2 **In-Service Devices**. The inspection and testing frequency of in-service auxiliary devices, unless otherwise stated, should coincide with the programs established in Section 6.12, “Inspection and Testing Classification”. Requirements to comply with manufacturers’ warranties should also be considered.

6.1.3.3 **Inspection**. An inspection for general condition of the metering installation shall be made before and after an auxiliary device is installed, removed or tested.

6.1.4 **Auxiliary Device Identification.** Each auxiliary device shall provide identification that shall include, at a minimum, the following information:

a) Manufacturer's name or trademark, serial number and type.
b) Additional data as specified in the requirements for each auxiliary device.

6.1.5 **Construction Requirements**

6.1.5.1 **Case Specifications**. The cases of auxiliary devices shall be of a sturdy design to provide physical protection for the operational elements. They shall be fabricated of a durable rust-resistant, moisture-proof material suitable for outdoor service in ambient temperatures of -40°F (-40°C) to 160°F (71°C) and shall be fitted with a cover or door of suitable material. All auxiliary devices shall be gasketed between the case and door. Provision for a seal or lock, or both, should be provided.

6.1.5.2 **Case Style**. Various case styles are considered acceptable for the direct- and remote-mounting auxiliary devices.

6.1.5.3 **Pressure Connection**. Each element for sensing pressure shall be supplied with a threaded connection within or extending from the case. The recommended thread size shall be 1/4" (6 mm) NPT (internal or external thread).

6.1.5.4 **Chart Plates**. Those auxiliary devices requiring circular charts shall be equipped with a chart plate. This chart plate shall be designed to provide proper support for the recording chart.

6.1.6 **Installation**

6.1.6.1 **Direct-Mounting Devices**. Those devices mounted directly to the meter should have positive attachment by means of latch, bolt or some other method.

6.1.6.2 **Remote-Mounting Devices**. Those devices remotely located from the meter but activated by the meter shall be rigidly supported. The connection from the meter to the remote device shall be firmly attached at both the meter and auxiliary device, and the entire assembly shall be suitably protected. Provisions shall be made for the independent removal of the meter or auxiliary device.

6.1.6.3 **Location of Sensing Probes**. When the meter installation requires the use of a pressure-sensing line, the manufacturer's reference pressure tap should be utilized. Where such location is impractical, the pressure tap should be located as close as practicable to the inlet connection of the meter.
The temperature-sensing probe should be located in the meter or within 5 pipe diameters downstream of the meter. If another location is necessary or desirable, the temperature difference between the meter and the temperature probe should not exceed 3°F (1.7°C).

6.1.7 **Acceptance Standards**

6.1.7.1 **Auxiliary Device Driving Torque**. Manufacturers shall publish maximum torque for all devices. Consideration should be given to the effect the torque will have on basic meter performance.

6.1.7.2 **Accuracy - Laboratory Conditions**. When this standard refers to the accuracy of an auxiliary instrument, the term shall be defined as a number or quantity, which defines the limit of error under reference operating conditions. Unless otherwise specified, accuracy is defined as that in effect under reference operating conditions. Accuracy is the combined or joint effects of method, observer, apparatus and environment. Unless stated otherwise, all accuracy statements in this standard refer to percent of maximum scale reading.

NOTE: Reference operating conditions referred to in this standard would be "laboratory condition" (i.e., 75°F ± 5°F (24°C ± 2.8°C), normal atmospheric pressure, clean gas).

6.1.7.2.1 Accuracy of pressure elements should be ±0.5% of full scale.

6.1.7.2.2 Accuracy of temperature elements should be ±1.5°F (±0.83°C).

6.1.7.2.3 Accuracy of pressure-recording devices should be ± 0.75% of full scale.

6.1.7.2.4 Accuracy of temperature-recording devices should be ±2.5°F (±1.39°C).

6.1.7.2.5 Accuracy of Integrating Devices. In addition to the basic accuracy of the pressure element and temperature element, an additional tolerance for each separate integrating function is required. These tolerances are included in the following:

6.1.7.2.5.1 Accuracy of pressure-integrating devices shall be 10.75% of the maximum pressure multiplier over a pressure range of 10% to 100% of maximum gauge pressure when the maximum gauge pressure is 150 psig (1034 kPa) or less. On higher pressure ranges, the above specified accuracy shall cover a range of 20% to 100% of the maximum gauge pressure.

6.1.7.2.5.2 Accuracy of temperature-integrating devices shall be ±0.75% of the maximum temperature multiplier over the full temperature range.

6.1.7.2.5.3 Accuracy of pressure- and temperature-integrating devices shall be ±1% of the maximum combined pressure and temperature multiplier over the full temperature range, and a pressure range of 10% to 100% of the maximum gauge pressure when the maximum gauge pressure is 150 psi (1034 kPa) or less. On higher pressure ranges, the specified accuracy shall cover a range of 20% to 100% of the maximum gauge pressure.

6.1.7.3 **Accuracy - Field Conditions**. It should be recognized that accuracy figures stated for laboratory conditions may need to be expanded to apply to field-type tests. This is necessary because the reference operating conditions can vary widely depending upon the prevailing ambient conditions.

6.2 PRESSURE SYSTEM

6.2.1 **Description.** A pressure system is one that measures pressures above or below atmospheric pressure at any point in a closed system. A pressure-differential device will measure pressure differences within a pressure system or between two pressure systems.

6.2.2 **Accuracy.** Accuracy of basic pressure elements should be as specified in 6.1.7.2.

6.2.3 **Types**

a) Bourdon tube
b) Metal diaphragm or bellows
c) Manometer
d) Transducer

6.2.4 **Basic Pressure Ranges — Gauge (lbf/in^2)**

0-5	0-150
0-15	0-300
0-30	0-600
0-60	0-1000
0-100	0-1500

0-30 in. of mercury vacuum

Note: For metric conversion lbf/in^2 × 6.8948 = kPa

6.2.5 **Pressure Elements.** It is recommended that the manufacturer provide interchangeability for the normal pressure ranges of specific types defined in 6.2.3.

6.2.6 **Pressure Systems.** Pressure systems shall be considered the same when such systems have the same:

a) Accuracy rating
b) Design rating
c) Performance rating
d) Range

6.3 TEMPERATURE SYSTEM

6.3.1 **Description.** A temperature system is one that indicates the relative hotness or coldness of the working media. A temperature-differential device measures relative temperature differences within a temperature system or between two temperature systems.

6.3.2 **Types**

a) Filled System
   1) Case Compensated
   2) Fully Compensated
b) Bi-Metallic System
   1) Case Compensated
   2) Fully Compensated
c) Electronic System
   1) Case Compensated
   2) Fully Compensated

6.3.2.1 **Case Compensated Temperature System**. With the bulb placed in an agitated 70°F ± 5°F (21.1°C ± 2.8°C) temperature bath, there shall be no more than 2°F (1.1°C) change in the indicated temperature of the temperature system when the case containing the calibrated temperature element is subjected to ambient temperatures between -20°F to 120°F (-28.9°C to 48.9°C).

6.3.2.2 **Fully Compensated Temperature System**. With the bulb placed in an agitated 70°F ± 5°F (21.1°C ± 2.8°C) temperature bath, there shall be no more than 3°F (1.67°C) change in the indicated temperature of the temperature system when the case and all but 5 feet (1.5 meters) of the capillary tubing are subjected to ambient temperature changes between -20°F to 120°F (-28.9°C to 48.9°C).

6.3.3 **Temperature Range**
The minimum temperature range of the system shall be 150°F (83.3°C) between the minimum and maximum limits of the element or device.

6.3.4 **Capillary Lengths**

Case Compensated (Feet)	Fully Compensated (Feet)
5	15
10	25
15	50
20	75
	100

Note: For metric conversion, ft. × 0.3048 = meters

6.3.5 **Sensing Bulb**

a) The material used for sensing bulbs shall be of the type that will not absorb or permit the escape of the sensing material.
b) Outer diameter: Should not exceed a diameter of 0.620-inches (15.7 mm).

6.3.6 **Temperature Wells**

6.3.6.1 **Well Materials**. Well materials should be selected to suit the application. Some of the common materials are:

a) Brass
b) Low-carbon steel
c) 316 SS
d) 304 SS
e) Nickel
f) Monel

6.3.6.2 **Well Dimensions**

a) External thread size: 3/4" (19 mm) N.P.T. or 1" (25.4 mm) N.P.T.
b) Internal thread size: 1/2" (12.7 mm) N.P.T.
c) Bore: Maximum allowable bore to be 0.630-inches (16 mm).
d) Well shall be designed to withstand a working pressure of 1,500 psig (10,342.2 Pa) at 150°F (65.6°C).
e) Standard lengths as measured below the external threads: 3", 5", 7", 10", and 12”
   Note: For metric conversion 1 inch = 25.4 mm.
f) See Figure 6.

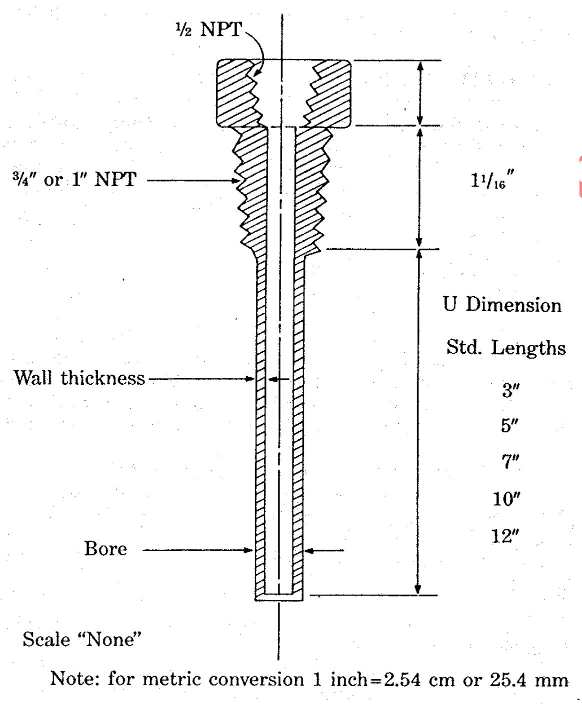


Figure 6. Temperature well dimensions.

6.3.6.3 **Temperature Well Construction**

6.3.6.3.1 The part of the temperature well projecting beyond the container must be as small as possible so to eliminate heat transfer to or from surroundings.

6.3.6.3.2 The temperature well shall be so constructed just inside the wall of the pipe that it has the smallest possible metallic section consistent with the necessary strength. This will tend to reduce the heat flow along the well with a given temperature difference and accordingly, will tend to maintain the maximum possible difference of temperature between opposite ends of the well.

6.3.6.4 **Temperature Well Installation**

6.3.6.4.1 The temperature well shall be so selected and placed that the bulb’s sensitive portion will be exposed to the flowing gas stream. The thermometer well shall be placed so as not to materially restrict the gas flow.

6.3.6.4.2 When metal-to-metal contact is not made between the bulb and its separable well, placing heat-conducting liquids in the well reduces time lag in the sensing of changing temperatures.

6.3.6.5 **Thermometer Installation**. When installing thermometers that are not compensated for ambient temperatures, the shortest possible standard length of capillary tubing shall be used.

6.4 VOLUME INDICATOR

6.4.1 **Description**. A volume indicator is a component of an auxiliary device designed to indicate on a scale or chart, or both, the volume of gas that has passed through a meter in relation to time, temperature or pressure, or any combination thereof.

6.4.2 **Types**

a) Chart, Clock-Driven
b) Chart, Meter-Driven
c) Demand Indicator

6.4.3 **Clock-Driven Chart.** A clock-driven chart shall record the volume in relation to time. Additional information on pressure or temperature, or both, may also be recorded on the chart. The volume per pen cycle should be clearly indicated.

6.4.4 **Meter-Driven Chart.** A meter-driven chart shall record the amount of volume by chart rotation. Additional information on pressure or temperature, or both, may also be recorded on the chart. The volume as recorded on the chart and as shown by the index shall not differ by more than ±0.5%.

Volume indicators shall have the volume per chart revolutions clearly indicated.

6.4.5 **Demand Indicator.** A demand indicator indicates on a scale, chart or tape the maximum volume metered during a predetermined period of time.

6.4.6 **Time Indicator.** In addition to recording pressure or temperature, or both, a volume recorder may be equipped with a time-driven pen to record time cycles on the chart.

6.5 INSTRUMENT CHART DRIVES

6.5.1 **Description.** An instrument chart drive or clock is a timing device used to provide a time base for auxiliary devices.

6.5.2 **Classification.** Instrument chart drives shall be classified in categories that indicate their initial drive force and time cycle.

6.5.3 **Types**

a) Mechanical
b) Pneumatic
c) Battery
d) Synchronous
    1) Standard Case
    2) Proof Case

6.5.4 **Specifications for Construction and Identification.** Each drive in its category shall be designated by type, time cycle and rewind period, where applicable. The direction of rotation shall be indicated, and the serial number, time cycle and manufacturer's name shall be prominently displayed on the clock or chart drive.

6.5.5 **Construction and Workmanship.** Each clock shall be constructed of acceptable material to attain repeatability of performance. Each clock shall be constructed in a manner that it can be used with universal adapters to fit various types of instrument cases. All clocks and turrets used as chart drives shall be constructed with arbors of 0.499-inch to 0.502-inch (12.67 mm to 12.75 mm) diameter. Automatic chart changer arbors need not conform to these dimensions.

6.5.6 **Basis of Acceptable Performance.** Clocks shall be considered acceptable when the timing element is not in error by more than ±4 minutes in 24 hours, tested under laboratory conditions as set forth in 6.1.7.2. In the application of the clock, consideration should be given to the ambient operating conditions.

6.6 CIRCULAR CHARTS

6.6.1 **Description.** A circular chart is a piece of paper, or other suitable material, with graduated lines upon which a pen or stylus draws a record indicating the variables being measured.

6.6.2 **Material**

6.6.2.1 Paper charts made from seven-point paper shall have a tolerance of 7.0 to 7.5 mils. The paper shall have a density of at least 51 lbs. per cubic foot or .82 grams per cubic centimeter and should have a surface smoothness and surface hardness designed to resist drag by the pen or stylus and to properly absorb the ink.

6.6.2.2 Charts made from other than paper should conform to the dimensional specifications set forth below.

6.6.3 **Dimensions**

6.6.3.1 **Measurement**. Dimensions of the printed image shall be based on Figure 7. The “a” dimension shall be the radius of any graduation taken across the grain of the paper. The “b” dimension shall be radius of any graduation. Radial dimensions shall be taken from the center of the graduation. All measurements shall be made after the paper has been conditioned for 24 hours at standard conditions of 73.4°F ±6.3°F (23°C ±3.5°C) and relative humidity of 50 percent ±2%.

6.6.3.2 **Mean Radius**. The mean radius shall be calculated from the expression:

$$\frac{a_1 + a_2 + b_1 + b_2}{4}$$

The mean radius of the zero and full-range graduations shall be within ±2 mils of the calculated or correct value. The mean radius of all other major graduations shall be within ±3 mils of the calculated or correct value.

6.6.3.3 **Size**.

6.6.3.3.1 All charts shall have a center hole, cut clean without any burrs or fuzz and 0.500-inch to 0.503-inch (12.70 mm to 12.78 mm) in diameter.

6.6.3.3.2 The outside diameter of charts shall be as recommended by the Original Equipment Manufacturer and shall have a tolerance of +0.000 to -3/32 inch (+0.000 mm to -2.381 mm).

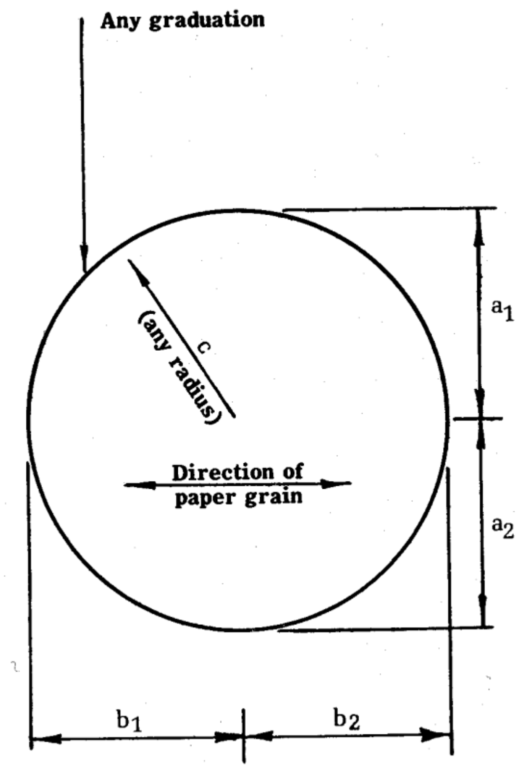


Figure 7. Circular chart dimension diagram.

6.6.3.4 **Eccentricity**. Eccentricity and roundness shall be measured by determining the maximum and minimum radii (C_{max} minus C_{min}). The value shall be calculated from the expression C_{max} minus C_{min}. The eccentricity shall not exceed 3 mils in the inner portion of the chart. Beyond a 3-inch radius, eccentricity shall not exceed 1.5 mils per inch (25.4 mm) radius.

6.6.3.5 **Major Graduations**. The charts shall contain major graduations representing some regular function of the full chart range. One of these graduation lines shall represent 0% of full-scale range and one shall represent 100% of full scale range. Line widths shall be 11 mils ±2 mils. When specified by the user, the zero graduation may be in accordance with specifications for minor graduations or intermediate graduation.

6.6.3.6 **Minor Graduations**. The charts shall have minor graduations between the major graduations. It is recommended that the number of these minor graduations be one, five or ten. Line widths shall be 3 mils ±1.5 mils.

6.6.3.7 **Sub-Major Graduations**. A sub-major graduation may be used between graduations to better delineate minor graduations. The line widths of sub-major graduations shall be 7 mils ±2 mils.

6.6.3.8 **Time Arc**. Time arc lines are nominally radial across the face of the chart from zero to full scale and shall follow the arc of the pen of the instrument for which the chart is intended. The time arc lines shall not deviate from the design radius of the pen arm by more than ±5 mils. The spacing between the time arc lines, referred to as the midpoints of the arc lines, shall not deviate at any point on the line from the correct angle ±0.50 when measured from a zero-reference line such as 12 noon. Major arcs such as hours or days shall have widths the same as major graduations.
Where the chart is graduated uniformly, it shall be graduated along the arc.

6.6.4 **Identification.** All charts shall be marked to show the name or trademark of the chart manufacturer, and an identifying code number established by the manufacturer, or the instrument number and the range of the identification number indicating the plate from which the chart was printed.

6.6.5 **Specifications.**

6.6.5.1 **Dimensional Stability—Humidity**. The chart shall be made of a material that will withstand a relative humidity variation of ±30% relative humidity from base conditions of 50% relative humidity with a total dimensional deviation of less than 1% when measured across the grain. Measurements shall be made on two samples, with one being raised to 80% relative humidity and the other being lowered to 20% relative humidity. The material shall have sufficient memory across the grain to return to within ±0.3% of the original dimensions after undergoing a 30% change in relative humidity and being restored to original conditions. Refer to 6.6.3.1 for dimensional measurements.

6.6.5.2 **Strength**. Paper shall have sufficient strength so as not to tear during normal operation of the instrument.

6.6.5.3 **Inking Qualities**. When used with the ink recommended by the manufacturer or supplier, the charts shall produce a clear, legible, unblurred record, without blotting or running. (See 6.6.5.6.) Tests shall be made using clean, standard pens mounted to simulate the actual recording method.

6.6.5.4 **Smoothness**. The chart shall have a surface so that there will be minimum resistance to the motion of the pen. The surface shall be free of particles that might tend to clog the pen point. Watermarks shall not be permitted.

6.6.5.5 **Finish**. Charts shall be printed on paper having an image face finish of 75 BEKK ±25% or a Sheffield finish between 60 and 120 prior to printing.

6.6.5.6 **Recording Inks and Pens**. The proper application of inks and pens depends on various factors. Among the factors to be considered are humidity, ambient temperature, type of pen design and capillary system.

6.6.5.7 **Chart Changers**. Chart changers for recording instruments shall be designed so that the resulting chart record is not adversely affected.

6.7 RECORDERS

Recorders may be used to record the variables of time, pressure, temperature or volume, or combinations thereof.

The recorders shall conform to the construction and acceptance standards of 6.1.5 and 6.1.7.

All recorders shall be installed in conformance with 6.1.6.

The components of these recorders shall conform to sections 6.2, 6.3, 6.4, 6.5 and 6.6, where applicable.

6.7.1 Pressure Recorders—Circular Charts

6.7.1.1 **Description**. A pressure recorder is an auxiliary device designed to record variations of pressure relative to time by means of a clock-driven circular chart.

6.7.1.2 **Identification**. All pressure recorders shall have permanent identification of pressure range and chart, in addition to the requirements of 6.1.4.

6.7.2 Temperature Recorders—Circular Charts

6.7.2.1 **Description**. A temperature recorder is a auxiliary device designed to record variations of temperature relative to time by means of clock-driven circular charts.

6.7.2.2 **Identification**. All temperature recorders shall have permanent identification of temperature range and chart, in addition to the requirements of 6.1.4.

6.7.3 Pressure and Temperature Recorders—Circular Chart

6.7.3.1 **Description**. A pressure and temperature recorder is an auxiliary device designed to record variations in pressure and temperature relative to time by means of a clock-driven circular chart.

6.7.3.2 **Identification**. All pressure and temperature recorders shall have permanent identification of pressure range, temperature range and chart, in addition to the requirements of 6.1.4.

6.7.4 **Pressure and Volume Recorder with Meter-Driven Circular Chart**

6.7.4.1 **Description**. A pressure-volume recorder is an auxiliary device designed to record variations in pressure relative to volume by means of a circular chart driven by the meter. The area under the pressure recording is related to the volume corrected for pressure.

6.7.4.2 **Identification**. All pressure-volume recorders shall have permanent identification of the pressure range, chart and rotational information, in addition to the requirements of 6.1.4.

6.7.5 **Temperature and Volume Recorder with Meter-Driven Circular Chart**

6.7.5.1 **Description**. A temperature-volume recorder is an auxiliary device designed to record variations of temperature relative to volume by means of a circular chart driven by the meter. The area under the temperature recording is related to the volume corrected for temperature.

6.7.5.2 **Identification.** All temperature volume recorders shall have permanent identification of temperature range and rotational information, in addition to the requirements of 6.1.4.

6.7.6 **Pressure, Temperature and Volume Recorder with Meter-Driven Circular Chart**

6.7.6.1 **Description**. A pressure-temperature-volume recorder is an auxiliary device designed to record variations in pressure and temperature relative to volume by means of a circular chart driven by the meter.

6.7.6.2 **Identification**. All pressure-temperature-volume recorders shall have permanent identification of pressure range, temperature range and rotational information, in addition to the requirements of 6.1.4.

6.7.7 **Pressure and Volume Recorder with Clock-Driven Circular Chart**

6.7.7.1 **Description**. A pressure and volume recorder is an auxiliary device designed to record variations of pressure and units of volume relative to time by means of a clock-driven circular chart.

6.7.7.2 **Identification**. A pressure and volume recorder shall have permanent identification of the pressure range, and chart and rotational information, in addition to the requirements of 6.1.4.

6.7.8 **Temperature and Volume Recorder with Clock-Driven Circular Chart**

6.7.8.1 **Description**. A temperature and volume recorder is an auxiliary device designed to record variations in temperature and units of volume relative to time by means of a clock-driven circular chart.

6.7.8.2 **Identification**. All temperature and volume recorders shall have permanent identification of temperature range, and chart and rotational information, in addition to the requirements of 6.1.4.

6.7.9 **Pressure, Temperature and Volume Recorder with Clock-Driven Circular Chart**

6.7.9.1 **Description**. A pressure, temperature and volume recorder is an auxiliary device designed to record variations in pressure and temperature and units of volume relative to time by means of a clock-driven circular chart.

6.7.9.2 **Identification**. A pressure, temperature and volume recorder shall have permanent identification of the pressure range, the temperature range, and chart and rotational information, in addition to the requirements of 6.1.4.

6.7.10 **Demand Recorder.**

A demand recorder records on a chart or tape the corrected or uncorrected volume metered during a recurring predetermined period of time. Demand recorders perform their function by means of a time-based chart, printout or tape.

6.8 AUTOMATIC INTEGRATORS

Automatic integrators automatically apply correction factors to a volume-related input. These correction factors can be the function of either single variables or multiple variables.

6.8.1 **Recording Type.** This type of automatic integrator is equipped with corrected and uncorrected volume counters and a chart to record the time, pressure, temperature or volume, or combination thereof.

6.8.2 **Non-Recording Type.** This type of automatic integrator is equipped with corrected and uncorrected volume counters.

6.8.3 Automatic Integrating Device for Pressure

6.8.3.1 **Description**. An automatic integrating device for pressure is an auxiliary device designed to automatically correct a volume-related input to some predetermined base pressure condition.

6.8.3.2 **Identification**. All automatic integrators for pressure shall have permanent identification of the pressure range, multipliers for counters, designated atmospheric pressure, contract base pressure and rotational information of the instrument drive, in addition to the requirements of 6.1.4. Information regarding the volume per revolution of the instrument drive should be affixed to the instrument. Where the automatic integrator is supplied in combination with a recorder, additional identification is required in conformance with the applicable portions of Section 6.7.

6.8.4 Automatic Integrating Device for Temperature

6.8.4.1 **Description**. An automatic integrating device for temperature is an auxiliary device designed to automatically correct a volume-related input to some predetermined gas temperature condition in accordance with Charles' Law.

6.8.4.2 **Identification**. All automatic temperature integrating devices shall have permanent identification of temperature range, multipliers for counters, base temperature, rotational information and volume per revolution of instrument drive, in addition to the requirements of 6.1.4. Where the automatic integrator is supplied with a recorder, additional identification is required in conformance with the applicable portions of Section 6.7.

6.8.5 Automatic Integrating Devices for Pressure and Temperature

6.8.5.1 **Description**. An automatic integrating device for pressure and temperature is an auxiliary device designed to automatically correct a volume-related input to some predetermined base pressure and base temperature condition in accordance with Boyle's Law and Charles' Law.

6.8.5.2 **Identification**. All automatic integrating devices shall have permanent identification for pressure and temperature ranges, multipliers for counters, atmospheric pressure, contract base pressure, base temperatures, rotational information and volume per revolution of instrument drive, in addition to the requirements of 6.1.4. Where the automatic integrator is supplied with a recorder, additional identification is required in conformance with the applicable portion of 6.7.

6.9 CONSTANT-PRESSURE-COMPENSATING INDEX

6.9.1 **Description.** A constant-pressure-compensating index is an index used to indicate a gas volume converted to a contract base pressure when used in conjunction with a gas meter operated at a constant pressure other than the contract base pressure. (Also see 2.8.8.)

6.9.2 **Construction**

6.9.2.1 **Test Dials**. All compensating indexes shall be equipped with a prover test dial designed to indicate the uncorrected volume being delivered through a gas displacement meter.

6.9.2.2 **Gear Ratios**. The gear train between the prover test dial and the 1,000-cubic-foot hand shall be designed to have a gear ratio, as near as practical, not to exceed ±0.75% to the theoretical ratio required to correct the indicated volume in accordance with Boyle's Law. This theoretical gear ratio shall be based on a designated atmospheric pressure, a contract base pressure and the pressure delivered through the meter.

6.9.2.3 **Identification**. Standard constant-pressure-compensating indexes shall be constructed with a red color dial face. Other colors may be used for dial circle background to improve readability. All markings and all lettering must be of contrasting color. The index face shall be permanently marked with the actual gear ratio in fractional form.

6.9.3 **Standard Ratings.** Standard constant-pressure indexes shall be manufactured to compensate, as nearly as practicable, for the following conditions:

a) 14.4 psia atmospheric pressure
b) 14.73 psia contract base pressure
c) 2, 5, 10, 15, 20, 30 or 50 psig metering pressure

Note: For metric conversion 1 lbf/in^2 = 6.8948 kPa

6.9.4 **Non-Standard Conditions.** Each manufacturer should provide a set of adjusted gas delivered pressure tables for each of their indexes, taking into account the following factors:

a) The difference between the theoretical and actual gear ratio.
b) Average atmospheric pressure in a minimum of 500-foot increments for the elevations from 0 to 5,000 feet above sea level.
c) Base pressures of 14.65 psia, 14.73 psia, 4 ounces above atmospheric and 8 ounces above atmospheric, respectively.

Note: For metric conversion 1 lbf/in^2 = 6.8948 kPa

6.9.5 **Application.** A small indicated gas volume error is sometimes introduced by the use of pressure-compensating indexes as it is not always practical to exactly match the required theoretical gear ratio since the average atmospheric pressure or the contract base pressure, or both, may be at variance with the standard design pressures. Methods of compensating for these errors and for proper use of the compensating indexes for other than the standard design atmospheric pressure and base pressure shall be considered.

6.10 REMOTE METER READING DEVICES

6.10.1 **Description.** A remote reading device for a gas meter continuously provides or reproduces a reading of the meter index, at a point remote from the meter. The reading may be displayed for visual observation, recorded in a portable device or transmitted to a distant point.

6.10.1.1 **Continuous Monitoring**. A continuous monitor is a device that transmits the volume reading to the remote register during the consumption period. Several of these types are:

a) Self-generating electrical pulsing device
b) Externally powered electrical pulsing device
c) Pneumatic pulsing device
d) Direct drive

6.10.1.2 **Periodic Interrogation**. A periodic interrogator is a device that transmits the volume reading to the remote location on a request basis or predetermined time basis. Several of these types are:

a) Encoder-register with electromechanical switching
b) Encoder-register with electro-optical switching

6.10.2 **General System Requirements**

6.10.2.1 **Compatibility**. The encoder-register component of a remote reading system shall be compatible with a maximum number of different gas meters in order to enhance its installation in an established gas distribution system. The encoder-register component shall not cause accelerated wear or shorten the useful life of the gas meter and shall comply with applicable safety standards.

6.10.2.2 **Accuracy**. The remote reading system shall reproduce the meter index reading within ±1 count. The addition of the system shall not be detrimental to the measurement accuracy of the meter itself.

6.10.2.3 **Readability**. The remote reading read-out shall have the same readability as required for the standard displacement meter index as detailed in section 2.8. If the remote reading system has an electrically illuminated display, it shall be readable under all conditions of lighting, including direct sunlight.

6.10.2.4 **System Compatibility**. If the system is of the recording type (punch card, magnetic tape, etc.), the recording system should provide data convertible to conventional data-processing equipment in current use.

6.10.2.5 **Installation**. The installation of the remote reading system shall be made in accordance with the manufacturer's specifications, including distance limitations between the gas meter and the remote station and use of properly sized electrical conductors. All materials used in making the installation shall be rust- and corrosion-resistant and shall not discolor the customer's property. The entrance of the conductor or conduit into the customer's home shall be made in such a manner as to prevent the entrance of water or vermin. Electrical wiring shall comply with all codes where applicable.

6.10.2.6 **In-Service Performance**. Reliability of the remote system shall be demonstrated by its continued ability to provide remote readings that reproduce the meter index. Local and remote components and the interconnecting conductors shall retain their structural integrity and be securely fastened in place.

6.10.3 **Encoder Specification**. The encoding register that is to be attached to the gas meter shall be identified with the following information, in addition to the requirements of 6.1.4.

a) Meter size and make
b) Units of measurement (e.g., cubic feet × 100)

6.10.4 **Remote Register Specification.** The remote read-out unit shall provide for positive identification of the customer to prevent billing errors. Units of measure shall be made in the design to permit the resetting of the remote register.

6.11 INSTRUMENT ADAPTOR PLATES

6.11.1 **Description.** An instrument adaptor plate is a mounting surface of suitable material mounted on and driven by a gas displacement meter. The instrument adaptor plate mounts between the meter and instrument and provides the correct instrument drive rotation and speed or displaced volume per revolution with respect to the meter output drive shaft.

6.11.2 **Instrument Adaptor Plate Identification.** All adaptor plates shall have a badge containing the following information:

a) Rotational information
b) Internal gear ratio
c) Position of adaptor plate relative to meter and instrument

6.12 INSPECTION AND TESTING CLASSIFICATION

6.12.1 **Classification of Inspection and Testing to Be Performed on Auxiliary Devices.**

6.12.1.1 Inspection should be made on all auxiliary devices for:

a. Physical damage
b. Mechanical defects
c. Conformance to standards as set forth herein

6.12.1.2 The complexity of the test and the number of test points should be a function of the desired operational data required and the economics involved. The test classification shall be designated as Type I, Type II and Type III.

6.12.1.2.1 **Type I Tests**. One or more points for the pressure system or the temperature system or both. It is recommended that one of the test points for each system be at nominal operating conditions.

6.12.1.2.2 **Type II Tests**. Three test points on the pressure system at approximately 10%, 50%, and 90% of the full range. Two test points on the temperature system spanning a minimum range of 30°F (16.7°C).

6.12.1.2.3 **Type III Tests**. Five test points on the pressure system at approximately 10%, 30%, 50%, 70%, and 90% of the full range. Three points on the temperature system at approximately 0°F, 60°F and 120°F (-17.8°C, 15.6°C and 48.9°C).

6.12.2 **Test Equipment.** Test equipment should conform to the requirements of 6.1.2.

6.12.3 **Auxiliary Devices Classification**

6.12.3.1 **New Types of Auxiliary Devices**. This classification includes all newly designed auxiliary devices. These devices shall be tested for acceptance at the applicable Type III test points and shall meet all applicable standards included in Part VII.

6.12.3.1.1 **Pressure Recorders**. These recorders shall not exhibit hysteresis errors greater than 0.50% of full scale and shall conform to the accuracy requirements of 6.1.7.2.3. All such tests shall be made using charts or scales certified by the manufacturer.

6.12.3.1.1.1 The procedure for testing pressure recorders shall be as follows:

a) Set zero
b) Apply pressure proceeding up scale to each test point
c) Apply full-scale pressure and proceed down scale to each test point
d) Check the pen arc and chart trace

6.12.3.1.2 **Temperature Recorders**. Recorders shall conform to the accuracy requirement of 6.1.7.2.4. All such tests shall be made using charts or scales certified by the manufacturer.

6.12.3.1.2.1 The procedure for testing temperature recorders shall be as follows:

a) With the probe in an agitated liquid bath at approximately 60°F (15.6°C), the temperature indicator should be set to coincide with the bath temperature after stabilization.
b) Check the calibration at approximately 0°F (- 17.8°C).
c) Check the calibration at approximately 120°F (48.9°C).

6.12.3.1.3 **Volume Recorders**. Volume recorder should be checked by rotating the input shaft the required number of revolutions to obtain one complete cycle of the volume indicator.

6.12.3.1.4 **Clocks**. Clocks shall conform to the requirements of 6.5.

6.12.3.1.5 **Automatic Pressure-Integrating Devices**. These devices shall be capable of adjustment so that all of the applicable specified test points in Section 6.12.1.2.3 conform to the accuracy limits of 6.1.7.2.5.1. These devices should be capable of being cycled up and down the scale at any of the specified test points.

6.12.3.1.6 **Automatic Temperature-Integrating Devices**. These devices should be capable of adjustment so that all of the applicable specified test points in Section 6.12.1.2.3 conform to the accuracy limits of Section 6.1.7.2.5.2.

6.12.3.1.7 **Automatic Pressure- and Temperature-Integrating Devices**. Accuracy, calibration and cycling tests of these devices shall conform to Sections 6.12.3.1.5 and 6.12.3.1.6, respectively, when each function is calibrated and tested individually. In all cases, the overall accuracy shall be within the limits specified in Section 6.1.7.2.5.3 when tested in combination at any of the specified pressure and temperature test points.

6.12.3.1.8 **Combination Recording or Integrating Devices or Both**. Auxiliary devices that include any combination of the devices covered by Section 6.12.3 shall conform to the specified requirement for the individual component. Only those components that are of new design shall be subject to the requirement of Section 6.12.3.1.

6.12.3.2 **Newly Purchased Types of Auxiliary Devices**. Newly purchased auxiliary devices are devices that have been previously approved under the requirements of 6.12.3.1 (New Types) and have never been in service. These devices should be inspected to ensure freedom from damage and mechanical defects, and to ensure conformance with the standards set forth. This may be accomplished by 100% inspection or by an acceptable statistical sampling plan.

6.12.3.2.1 **Recording and Integrating Devices**. These devices shall be tested for acceptance at the applicable Type I or Type II test points. The intended application of the auxiliary device should determine the type test points to be used. They should also meet all applicable portions of sections 6.7 and 6.8.

6.12.3.2.2 **Pressure-Compensating Indexes**. These devices should conform to section 6.9. They should be tested by checking the gear ratio between the input shaft and the first reading circle.

6.12.3.3 **In-Service Types**. In-service auxiliary devices are devices that are, or have been, in service.

6.12.3.3.1 Recording or integrating in-service auxiliary devices shall be either field tested or shop tested in conformance with the applicable Type I test points as specified in 6.12.1.2.1. Where these devices are found to be outside the limits of point accuracy of 98% to 101%, they shall be adjusted to a point accuracy within 98% to 101%.

6.12.3.3.1.1 Tests on recording and integrating devices should coincide, where practical, with the periodic meter test. However, the period between tests on the auxiliary devices may be altered if a surveillance system is in effect.

PART VII
TEST METHODS AND EQUIPMENT

7.1 SCOPE

This part establishes identification of measurement standards, test equipment and test methods for gas displacement meters and related measurement devices.

7.2 MEASUREMENT REFERENCE BASIS

The final authority for all standards of measurement in the United States is the National Institute of Standards and Technology (NIST), U.S. Department of Commerce, whose function includes the following assigned by Public Law 619 of the 81st Congress (64 Stat. 371, 5USC 271-286): “The custody, maintenance and development of national standards of measurements, and the provision of means and methods for making measurements consistent with these standards.”

7.3 UNITS OF MEASURE

The legal values of measure are those represented by, or derived from, the national standard. Within the scope and purpose of this standard, all units of measure that are necessary in the testing of gas displacement meters, meter testing devices and associated apparatus shall conform to those legal values.

7.4 BASE CONDITIONS

For the purpose of defining a volumetric unit for measure of gas, a base pressure and temperature must be established, because of the behavior of gases when subjected to changes of pressure or temperature.

Boyle’s Law states that the volume occupied by a given mass of gas varies inversely with the absolute pressure if the temperature remains constant.

Charles' Law states that the volume occupied by a given mass of gas varies directly with the absolute temperature if the pressure remains constant.

By combination of these two laws, the relationship of “PV/T = Constant” is derived.

These laws are exactly applicable as stated only to perfect gases—which do not exist. Actual gases at elevated pressure deviate from these laws.

At an absolute pressure close to one atmosphere, the deviation is negligible so that a volume measured at an observed pressure and temperature other than the established base pressure and temperature may be corrected to base conditions by the formula:

$$V_b = V_f \times \frac{P_f}{P_b} \times \frac{T_b}{T_f}$$

where

V_b = volume at base conditions
V_f = volume registered by meter
P_f = flowing pressure metered, absolute
P_b = base pressure, absolute
T_f = flowing temperature, absolute
T_b = base temperature, absolute

In testing a gas meter for accuracy, it is not necessary that the gas be at base conditions; however, the reference volume and the compared metered volume must be referred to the same conditions. When the two are not at the same conditions, one must be corrected to the condition of the other by use of the above formula.

When the pressure difference between the reference volume and the metered volume is greater than one atmosphere, the effect of deviation from the perfect or ideal gas laws should be considered through the use of the following formulae or appropriate tables, see the "Manual for the Determination of Supercompressibility Factors (F_{pv}) for Natural Gas," PAR Research Project NX-19, or "Compressibility and Supercompressibility for Natural Gas and Other Hydrocarbon Gases," AGA/TMC Report No. 8.

The formula using compressibility factors is as follows:

$$V_b = V_f \times \frac{P_f}{P_b} \times \frac{T_b}{T_f} \times \frac{Z_b}{Z_f} \quad \text{when} \quad Z_b = \frac{1}{\left(F_{pv}\right)_b^2} \quad \text{and} \quad Z_f = \frac{1}{\left(F_{pv}\right)_f^2}$$

Substituting in the above equation:

$$V_b = V_f \times \frac{P_f}{P_b} \times \frac{T_b}{T_f} \times \frac{\left(F_{pv}\right)_f^2}{\left(F_{pv}\right)_b^2}$$

where

$(F_{pv})_f$ = supercompressibility factor at flowing conditions
$(F_{pv})_b$ = supercompressibility factor at base conditions
Z_f = compressibility factor at flowing conditions
Z_b = compressibility factor at base conditions

7.5 METER TESTING SYSTEMS

7.5.1 General.

This section describes the systems, test equipment and methods that are currently available and accepted for testing the accuracy of meters.

7.5.2 Test Requirement.

The necessary requirements in an acceptable system of testing are the ability to perform suitable tests with adequate accuracy.

7.5.3 Accuracy.

The highest reasonable accuracy should be obtained in testing. The accuracy of any method of testing is dependent on many factors that include:

a) **Accuracy of Test Standards**. The accuracy of a device or meter used as a standard for testing displacement gas meters is the accuracy obtainable with reasonable skill in practical use. The accuracy varies with the type of device and is affected by many factors including ambient temperature variations, pressure variations, length of scale, accuracy of scale markings, friction, torque and seal viscosity.
b) **Uncertainties of Observation**. Errors of observation may be due to estimation of fractions of scale divisions, improper averaging of instrument readings during fluctuating flow, parallax, and start and stop errors of standard gasometer, meter or timing device.
c) **Uncertainties in Method of Test**. Errors in method of testing are due to improper use of standards, improper calculations of measurements or improper connections of test unit to standard.

7.5.4 Suitability of Test System.

Test systems should, under normal conditions, be designed for use with various types of meters. In-service test systems should involve minimum size and weight and be designed for convenient use with the meter installation normally found.

7.5.5 **Bell, Piston, and Transfer Provers.**

7.5.5.1 **Description**. The bell prover is a positive or negative low-pressure, liquid-sealed, counter-balanced gasometer that is calibrated for use as a device to measure the volume of gas delivered to or received from a meter.

The piston prover is a positive low-pressure, mechanically sealed, hydraulically balanced gasometer that is calibrated for use as a device to measure the volume of gas delivered to a meter.

The transfer prover is a reference meter of known accuracy, with associated equipment required for its operation as a calibration system.

Each of these provers may be equipped to operate manually or semi-automatically.

7.5.5.2 **Method of Testing**. The meter to be calibrated should be connected to a prover of adequate volume to permit the duration of any test to provide both an integral number of cycles of the meter mechanism and an integral number of revolutions of a displaced volume indicator.

If these conditions are not obtainable, the test should be based on a sufficient volume to cause the effect of partial revolutions of the meter mechanism, and metered volume indicator, to be less than ±0.1%.

The volume registered by the meter indicator is compared with the volume indicated by the prover, both corrected to the same pressure and temperature, as an indication of the accuracy of the meter.

7.5.5.3 **Pressure and Temperature Control**. A correction for pressure difference between a prover and meter should be applied whenever the pressure differential at any flow exceeds 0.4-inch water column (100 Pa).

The pressure variation within the prover bell should not exceed 0.05-inch water column (12 Pa) throughout the travel of the bell.

Meters may be tested at any convenient temperature provided the following conditions are considered:

a) If meter, prover and proving environment are within 0.5°F (0.3°C) of the same temperature, no temperature correction is needed.
b) If meter, prover and proving environment are at temperatures differing more than 0.5°F (0.3°C), temperature correction shall be applied.
c) If the temperature of the proving environment is changing by more than 1.0°F (0.6°C) in an hour, testing is not recommended.

Test flow rates shall be in accordance with 4.2.4.

7.5.5.4 **Meter Accuracy**. For equivalent results in testing meters under pressure or vacuum proving:

$$\text{Percent Accuracy} = \frac{V_m}{V_p} \times \frac{P_m}{P_p} \times \frac{T_p}{T_m} \times 100$$

where

V_m = metered volume registered
V_P = prover volume displaced
P_m = meter inlet pressure, absolute
P_p = prover pressure, absolute
T_m = meter outlet air temperature, absolute
T_p = prover air temperature, absolute

For pressure proving, P_m and P_p will have values above atmospheric pressure; however, for vacuum-proving P_m will equal atmospheric and P_p will be below atmospheric pressure.

"Percent Accuracy" is recommended for use as a standard for comparing meter accuracy statistics. Formulae listed in Appendix D are some of the other methods used to determine meter test results.

7.5.6 **Low-Pressure Orifice Flow Provers and Critical Flow Orifice Provers.** In addition to the volume displacement devices used for meter proving, such as bell provers and portable transfer provers, there are other provers. These devices can be used for determining the accuracy of displacement meters at their in-service locations.

7.5.6.1 **Low-Pressure Flow Orifice Prover**. Two types of low-pressure orifice flow provers are currently available. On one type of prover, the differential pressure is measured across a pipe tap located one pipe diameter upstream of the orifice disc and a second pipe tap located approximately eight pipe diameters downstream of the orifice disc. The pressure eight pipe diameters downstream is normally equal to the atmospheric pressure. This being the case, only the upstream pressure is sensed to obtain differential pressure. This prover, construction-wise, resembles a pipe tap orifice meter. On the other type prover, the differential pressure is measured across flange taps provided in the upstream and downstream orifice disc flanges.

The prover is essentially a flange tap orifice meter. Complete instructions for use of low-pressure flow orifice provers can be found in the following publications:

AGA Gas Measurement Committee Report No. 6, Methods of Testing Large Capacity Displacement Meters: "Part I—Low Pressure Flow Orifice Provers (Pipe Tap)," "Part II—Low Pressure Flow Orifice Provers (Flange Tap)"

The low-pressure orifice flow prover resembles a pipe tap orifice meter and consists of two sections of pipe held together by specially designed orifice flanges equipped with fast connecting bolts. Each prover is equipped with provisions for measuring pressure and temperature, as required. The orifice discs are individually calibrated against a bell prover and the time required to pass 1 cubic foot (0.0283 m^3) of air at standard conditions is stamped on the downstream side of the disc. Air, the source of which may be a portable blower, is normally the test medium. Where it may be safely exhausted into the atmosphere, natural gas may be used as a test medium.

7.5.6.2 **Use of the Low-Pressure Orifice Flow Prover**. The various parameters are read out on gauges associated with the flow prover, and convenient tables for use with these readings are referenced to calculate the instantaneous flow rate. It is necessary, therefore, that the pressure and gas flowing temperature between meter and prover remain constant during the course of a test run. The average of several readings taken during a run may give accurate results if fluctuations are sufficiently small.

If a blower is used to provide air flow for pressure testing, there is the possibility that the flowing temperature will change so rapidly that accurate averaging will be difficult. To overcome this condition, it may become necessary to change from pressure-proving to vacuum-proving. In vacuum-proving, the inlet of the blower is installed on the outlet of the meter being calibrated and ambient air is caused to move through both the flow prover and the meter under test. Similar tables may be used for vacuum-proving as in pressure-proving; however, since the relation of the meter and the prover are different, the pressure and temperature adjustments for the difference between meter and prover may be different.

7.5.6.3 **Critical Flow Orifice and Sonic Flow Nozzles**. The critical flow orifice and sonic flow nozzle provers are devices that can be used to test displacement meters at elevated pressures. Gas or air is passed through the meter and the prover, then discharged into the atmosphere. Its components are a short piece of pipe with a high-pressure orifice holder on the end, a calibrated orifice or nozzle, and taps for measuring upstream pressure and temperature.

To perform a test, the prover is connected directly to the meter outlet. To ensure critical flow has been reached in the prover, it is necessary that the ratio of absolute inlet pressure to absolute outlet pressure be at least 2-to-1 for critical orifice discs and 1.25-to-1 for sonic nozzles. The prover nozzle or orifice is calibrated in terms of "Standard Time" for a known flow. This is compared with a "Test Time" derived by timing the proper number of revolutions of the proving hand on the meter under test. This timing is usually done with a hand-held stopwatch, and the test interval should be at least 3 minutes to minimize errors. Critical flow-proving requires considerably more gas than proving with a low-pressure prover for the same index registration. This increase is approximately equal to:

$$\text{Increase} = \frac{\text{Flowing Pressure Absolute}}{\text{Atmospheric Pressure}}$$

Flow tests run with a critical flow prover will cause noise levels considerably higher than those resulting from other proving methods. Additional information on the use of critical flow provers can be found in the following publications:

a) *AGA Gas Measurement Committee Report No. 6, Methods of Testing Large Capacity Displacement Meters*, "Part IV—Critical Flow Prover"
b) *AGA Gas Measurement Manual Part No. 12, Meter Proving*

7.6 **CALIBRATION OF METER TESTING SYSTEMS**

7.6.1 **General.**

Calibration of meter testing systems shall be conducted under known and controlled conditions, wherein the accuracy of volumetric containers, tapes, scales and other state-of-the-art measurement devices are traceable to the National Institute of Standards and Technology.

Meter testing systems shall be calibrated when first installed and following alterations, damage or repairs that might effect accuracy. To ensure that the accuracy of the meter testing systems is maintained on a continuous basis, a daily leakage test shall be made and a periodic accuracy indication with a test meter of known accuracy shall be made. If the test results differ by more than ±0.5% from the test meter accuracy, the cause of error shall be determined, and necessary corrections made prior to reuse of the system**.**

7.6.2 **Calibration of Bell- and Piston-Type Provers.**

Bell- and piston-type gas meter provers or gasometers shall be calibrated with an immersion-type cubic-foot bottle or cubic-foot standard or by dimensional measurement using state-of- the-art techniques.

All provers shall be calibrated for the entire length of the prover scale. Provers used for testing meters at less than rated prover volume shall also be calibrated at scale reference points used in the meter tests.

7.6.2.1 **Calibration by Volumetric Comparison**. Volumetric calibrations may be established by the transfer of a gaseous volume from a cubic-foot bottle or standard into a prover bell or from a prover bell into a cubic-foot bottle or standard. Calibration shall be conducted under stable temperature conditions where temperature differences of all equipment and ambient air do not exceed 0.5°F (0.3°C) unless proper correction is applied. Sealing fluid for use in the bell prover and the cubic-foot bottle or standard shall be an oil or other medium of low vapor pressure and low viscosity corresponding to the typical specifications in Table VII.

TABLE VII

SPECIFICATION, PROVER SEALING FLUID

Viscosity at 100°F (37.8°C)	55-75 seconds Saybolt (11×10^{-6} to 14.5×10^{-6} m^2/s)
Vapor Pressure at 200°F (93.3°C)	Less than 0.60 mm mercury (80 Pa)
Specific Gravity at 60°F (15.6°C)	0.848 to 0.878 (water, 1.0)
Pour point	Not more than 25°F (-4°C)
Flash point	Not lower than 300°F (149°C)
Fire point	Not lower than 310°F (154°C)

7.6.2.2 **Calibration by Dimensional Measurement**. Calibration of bell and piston provers may be more consistently achieved by physical measurements than by volumetric comparisons because temperature and pressure variations have no appreciable effect on measurement. The capacity of a prover bell or its internal volume discharged between any two points of travel will be equal to the cylinder volume above the sealing liquid at the first position, minus the cylinder volume above the liquid at the second position, plus the volume of metal in scale and other appurtenances that become immersed in the liquid, and minus the volume of seal fluid that rises between the outside of the bell and the main tank. To ensure accurate results, the prover bell and counterweights must be adjusted to provide the same pressure within the bell at any bell position, and a minimum of 3 minutes must be allowed for sealing liquid drainage prior to measurements.

Volume of air (Q) displaced by the bell is expressed by the formula:

$$Q = 0.7854\ [A^2L – (R^2 - A^2)\ I + G^2FH] + CDE + J$$

where

A = Average prover bell outside diameter
C = Scale length immersed in seal
D = Scale width
E = Scale thickness
F = Scale button length
G = Scale button diameter
H = Number of scale buttons immersed in seal
I = Rise in seal level
J = Volume of appurtenances immersed in seal
K = Average distance between tank and bell
L = Length of prover scale between zero and point in question
R =Inside diameter of tank (A + 2K)

Details of the test procedure are covered in Appendix E.

The piston prover, usually a large-volume gasometer, is readily calibrated by dimensional measurement, where the effective diameter of the cylinder may be determined with an inside micrometer with extension rods. The stroke of the piston may be defined using a pin bar that actuates an electronic counter, or other instruments of comparable accuracy. The accuracy of these measurement devices shall be traceable to the National Institute of Standards and Technology. Displaced volume (Q) may be expressed by the formula:

$$Q = 0.7854\ (A^2 – B^2)\ C$$

where

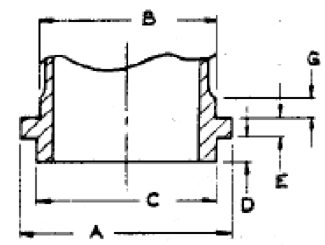
A= Cylinder inside diameter
B= Piston rod diameter
C= Piston stroke

7.6.3 **Calibration of Transfer Provers.** Transfer provers shall be calibrated under controlled temperature, pressure and flowing conditions and the accuracy of the prover determined at a sufficient number of points to enable a reliable flow rate versus accuracy curve to be drawn over the full range of its intended use. Calibration tests shall be performed using a reference standard of known accuracy such as a bell- or piston-type prover of adequate capacity. Pressure and temperature differences between the reference standard and the transfer prover shall be recorded at each flow rate and the volume appropriately corrected. The transfer prover sensing and timing equipment, temperature sensor and read-out, pressure sensor and read-out, and timing indicators shall be checked and calibrated against recognized standards of known accuracy.

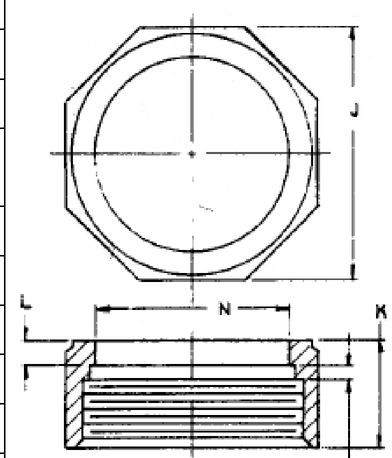
APPENDIX A
CONNECTION DIMENSIONS, NOMINAL

(This Appendix is information and not a part of the standard)

Connection Designation	5 Lt.	10 Lt.	#1 Sprague	1" Pittsburgh	20 Lt.	#2 Sprague	30 Lt.	45 Lt.	#4 Sprague	60 Lt.	100 Lt.	#5 Sprague
A Dia.	1	1-5/16	1-15/32	1-15/32	1-11/16	1-3/4	1-29/32	2-1/8	2-7/32	2-5/16	2-27/32	3-1/4
B Dia.	27-32	1-3/32	1-5/16	1-5/16	1-3/8	1-5/8	1-21/32	1-29/32	1-61/64	1-29/32	2-13/32	2-27/32
C Dia.	¾	1	1	1	1-5/16	1-15/64	1-1/2	1-45/64	1-1/2	1-29/32	2-7/32	2-5/16
D	5/32	5/32	3/16	3/16	3/16	3/16	¼	¼	3/16	¼	¼	¼
E	1/8	1/8	5/32	5/32	5/32	7/32	5/32	5/32	3/16	5/32	3/16	¼
G	7/64	1/8	3/16	3/16	5/32	7/32	11/64	3/16	3/8	3/16	¼	¼
J Flats	1-19/64 Oct.	1-39/64 Oct.	1-7/8 Hex	1-7/8 Hex	2 Oct.	2-7/32 Hex	2-7/32 Oct.	2-1/2 Oct.	2-13/16 Oct.	2-41/64 Oct.	3-7/16 Oct.	3-55/64 Hex
K	11/16	11/16	27/32	7/8	13/16	31/32	29/32	31/32	1-1/16	31/32	13/16	1-7/16
L	1/8	9/64	5/32	3/16	5/32	5/32	11/64	3/16	¼	3/16	¼	19/64
M (Max.)	5/32	5/32	7/32	3/16	3/16	¼	3/16	3/16	7/32	3/16	3/16	7/32
N Dia.	7/8	1-5/32	1-11/32	1-11/32	1-13/32	1-43/64	1-11/16	1-15/16	2	1-15/16	2-7/16	2-31/32
O Dia.	13/16	1-1/16	1-1/16	1-1/8	1-11/32	1-5/16	1-35/64	1-3/4	1-19/32		2-9/32	2-3/8
P (Min.)	7/32	7/32	¼	¼	¼	¼	5/16	5/16	¼	5/16	7/16	5/16
R – Min Full Thd. or Undercut	7/16	7/16	17/32	17/32	½	19/32	19/32	5/8	5/8	5/8	3/4	7/8

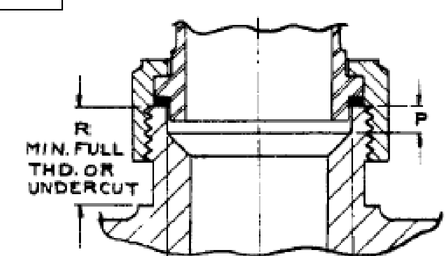


SWIVEL



CONNECTION NUT

M
SHOULDER
TO FULL THD



METER CONNECTION
ASSEMBLY

NOTE: All dimensions are posted in inches. Metric conversion is not provided

APPENDIX B
THREAD SPECIFICATIONS

(This Appendix is information and not a part of the standard)

Note: Unified Thread Form – Throughout except as noted.

Connection Designation	5 Lt.	10 Lt.	#1 Sprague	1” Pittsburgh	20 Lt.	#2 Sprague	30 Lt.	45 Lt.	#4 Sprague	60 Lt.	100 Lt.	#5 Sprague
Threads/Inch	12	11½	12	1¼-11½ N.P.S.	11½	11½	11½	11½	11½	11½	11½	8
External Major Diameter	1.1138 1.1310	1.4234 1.4411	1.5759 1.5931	---	1.8164 1.8341	1.8578 1.8755	2.0348 2.0525	2.2543 2.2720	2.3208 2.3385	2.4253 2.4430	3.001 3.006	3.4407 3.4632
External Pitch Diameter	1.0669 1.0769	1.3746 1.3846	1.5290 1.5390	---	1.7676 1.7776	1.8090 1.8190	1.9860 1.9960	2.2055 2.2155	2.2720 2.2820	2.3765 2.3865	2.9445 2.9495	3.3706 3.3820
External Minor Diameter	1.0288	1.3344	1.4909	---	1.7274	1.7688	1.9458	2.1653	2.2318	2.3363	2.896	3.3098
Internal Major Diameter	1.1390 Min.	1.4491 Min.	1.6011 Min.	1.650 1.656	1.8421 Min.	1.8835 Min.	2.0605 Min.	2.800 Min,	2.3465 Min.	2.4510 Min.	3.031 Min.	3.4712 Min.
Internal Pitch Diameter	1.0849 1.0962	1.3926 1.4043	1.5470 1.5585	1.588 1.591	1.7856 1.7974	1.8270 1.8390	2.0040 2.0160	2.2235 2.2358	2.2900 2.3023	2.3945 2.4068	2.961 2.969	3.3900 3.4049
Internal Minor Diameter	1.049 1.060	1.355 1.367	1.511 1.522	1.543 1.550	1.748 1.760	1.789 1.801	1.966 1.978	2.186 2.198	2.252 2.265	2.357 2.369	2.922 2.937	3.336 3.351
Pipe Size Normally Used	½”	¾”	1”	1”	1’	1¼”	1¼”	1½”	1½”	1½”	2”	2” F

NOTE: All dimensions are posted in inches. Metric conversion is not provided

APPENDIX C
GENERAL SERVICE CAPACITY EQUATION

The capacity of diaphragm meters at temperatures within the manufacturer's limiting range and at pressures within the design working pressure can be approximated by the following equation:

$$Q{=}2.18C\left(\frac{0.6}{G}\right)^{0.5}\left(\frac{520}{T+460}\right)^{0.5}\left(\frac{P_s+P_a}{14.73}\right)^{0.75}$$

Where:

Q = Recommended gas meter capacity in ft^3/h at specified condition.

2.18 = Differential pressure correction factor = $\left(\frac{1.9}{0.4}\right)^{0.5}$

C = Meter Capacity Class (See Sec. 3.2)

G = Specific gravity of gas (Air = 1.0)

T= Operating temperature, °F

P_s = Service pressure, psig (see note)

P_a = Actual atmospheric pressure, psia

NOTE: When P_s exceeds 250 psig, meter capacity shall be limited to that flow that will produce a differential pressure (h_m) of 8 inches w.c.

EXPLANATION:

The exponent 0.75 in the last factor (the pressure factor) of the equation has been chosen so that the stress and wear on a meter operating at elevated pressure is about the same as if the meter were operating near atmospheric pressure. If the service capacity were calculated using an exponent of 1, at high pressure the meter would operate at the same index rate as at low pressure, but the resulting increased differential pressure would cause an increase in stress and wear. If, on the other hand, the service capacity were calculated using an exponent of 0.5, the differential pressure would remain the same as at low pressure, but the meter's capacity would be unnecessarily restricted. But, by using the exponent of 0.75, this equation calculates a service capacity, which at high pressure permits the differential pressure to increase somewhat while decreasing the index rate. Experience has shown that with this trade-off between differential pressure and index rate, the stress and wear on a meter operating at elevated pressure is about the same as if the meter were operating near atmospheric pressure.

Example: What would be the recommended maximum capacity of a Capacity Class 1400 meter operating at 25 psig with a 0.57 specific gravity gas, a temperature of + 40°F, a barometric pressure of 14.70 psia and a base pressure of 14.73 psia?

$$Q=(2.18)(1400)\left(\frac{0.6}{0.57}\right)^{0.5}\left(\frac{520}{40+460}\right)^{0.5}\left(\frac{25+14.7}{14.73}\right)^{0.75}$$

$$Q=6717\,\frac{ft^3}{h}$$

An approximation of the operating differential pressure across a meter in service at elevated pressure (with imposed higher densities due to pressure increase) may be obtained from the following:

$$h_m = \left(\frac{(0.4)(Q)^2(14.73)}{C^2(P_s + P_a)}\right) + 0.1$$

Where:

h_m = Estimated operating differential pressure in inches w.c., at a flow rate of Q and at a service pressure of P_s

In the above example, the differential pressure (h_m) would approximate:

$$h_m = \left(\frac{(0.4)(6717)^2(14.73)}{(1400)^2(25 + 14.70)}\right) + 0.1 = 3.52 \text{ inches w.c.}$$

ESTIMATED INDEX RATE

The uncorrected index rate of a meter operating at elevated pressure may be approximated as follows:

$$\text{Index rate} = \frac{(14.73)}{(P_s + P_a)}(Q)$$

In this same example, the index rate would be:

$$\text{Index rate} = \frac{(14.73)}{(25 + 14.70)}(6717) = 2492\frac{\text{ft}^3}{\text{h}}$$

APPENDIX D
METER ACCURACY

(This Appendix is informative and is not part of the standard)

Meter accuracy can be expressed in numerous different manners. The following information provides a resource for terminology and mathematical representation.

Percent Accuracy, or **Percent Registration**, expresses the registration of volume by the meter relative to a known standard or reference, and is expressed as a percentage. Results less than 100% indicate the meter is 'slow' as compared to the standard, and values above 100% indicate the meter is 'fast' as compared to the standard.

$$= \frac{V_m}{V_s} \times 100$$

Other methods of reporting meter accuracy may also be expressed as:

Percent Deviation, or **Percent Error,** expresses the difference in the meter registration and the standard relative to the standard and is expressed as a percentage. The result indicates the percent either fast or slow relative to the standard. A negative value indicates the metered volume is slow by the calculated percent.

$$= \frac{V_m - V_s}{V_s} \times 100$$

Percent Proof is the reciprocal of Percent Accuracy and expresses the volume of the standard relative to the metered volume and is expressed as a percentage. May be used as a multiplier times a metered volume to state the correct volume relative to the standard.

$$= \frac{V_s}{V_m} \times 100$$

Percent Correction expresses the difference in the meter registration and the standard relative to the metered volume and is expressed as a percentage. When applied as a factor to a metered volume, the result will indicate the volume difference of the metered volume from the standard. A negative value indicates the meter is slower or has under reported the volume.

$$= \frac{V_m - V_s}{V_m} \times 100$$

Percent Error in Delivery expresses the difference in the standard and meter registration relative to the metered volume and is expressed as a percentage. When applied as a factor to a metered volume, the result will indicate the unmeasured volume difference of the metered volume from the standard. A negative value indicates the meter is faster or has over reported the volume.

$$= \frac{V_s - V_m}{V_m} \times 100$$

Correction Factor expresses the ratio of the standard to meter registration. Similar to Percent Proof, but not expressed as percentage.

$$= \frac{V_s}{V_m}$$

Where:

V_m = Volume indicated by meter

V_s = Volume indicated by standard (Corrected prover Volume)

For non-temperature compensated meters.

$$V_s = V_p \left(\frac{P_p}{P_m}\right)\left(\frac{T_m}{T_p}\right)$$

For temperature compensated meters.

$$V_s = V_p \left(\frac{P_p}{P_m}\right)\left(\frac{T_b}{T_p}\right)$$

Where:

V_p = Prover volume displaced

P_p = Prover pressure absolute

P_m = Meter inlet pressure absolute

T_p = Prover air temperature absolute

T_m = Meter outlet air temperature absolute

T_b = Base temperature on index dial

APPENDIX E
PROPER BELL CALIBRATION BY PHYSICAL MEASUREMENT

(This Appendix is informative and is not part of the standard.)

THEORY:

By inspection of Figure E-1:

(1) $Q = B + W$

(2) $B = V - M$

(3) $M + S = T + W$ and $W = M + S - T$

Substituting (2) in (1):

(4) $Q = V - M + W$

Substituting (3) in (4):

(5) $Q = V - M + M + S - T$

Therefore:

(6) $Q = V + S - T$

Where;

Q = Volume of air displaced by bell being lowered from point 0 to point in question

W = Volume displaced by the liquid that rises between the inner tank and the interior of the bell

B = Interior volume of the bell between point 0 to point in question

V = Volume of the outside of the bell

M =Volume of the metal of the bell

S = Volume of the scale

T = Volume displaced by the liquid that rises between the outside of the bell and the main tank

MEASURING INSTRUMENTS

Strapping Tape — A metal tape calibrated to convert circumferential measurements to diameter measurements, including a correction for its own thickness. If other than a strapping tape is used, then the apparent circumference measurement must be reduced by 3.14 times the tape thickness.

Depth Micrometer — 0" to 4" [0-100 mm]

Vernier Caliper — 0" to 6" [0-150 mm]

Steel Scale — Divided into 1/100 inches [0.25 mm]

Measurements Required — (All measurements in same units)

A = Average prover bell outside diameter

C = Length of prover scale moving in and out of the liquid seal

D = Width of prover scale

E = Thickness of prover scale

F = Scale button length

G = Scale button diameter

H = Number of buttons moving in and out of the liquid seal

I = Rise in liquid seal for bell travel between 0 and point in question

J =Volume of other appurtenances moving in and out of the liquid seal

K = Average distance between outer surface of bell and inner surface of outer prover tank

L = Length of prover scale between 0 and point in question

Q =Volume of bell

R = Inside diameter of tank

MEASURING PROCEDURES:

Determination of A:

Scale may be removed, otherwise the strapping tape must be around the bell, but not the scale. Measure the outside diameter of the bell with the strapping tape in five equal divisions of that portion of the bell that moves in and out of the seal. Apply approximately 2 pounds (10 N) of force in tension. While measuring, care must be taken that the tape lies flat on the bell and that it is positioned perpendicularly to the axis of the bell. Record and calculate the average diameter.

Determination of C, D, and E:

Scale must be left on the bell in order to determine the length moving in and out of the liquid seal from zero to the point in question (when the scale leaves seal completely during course of prover operation).

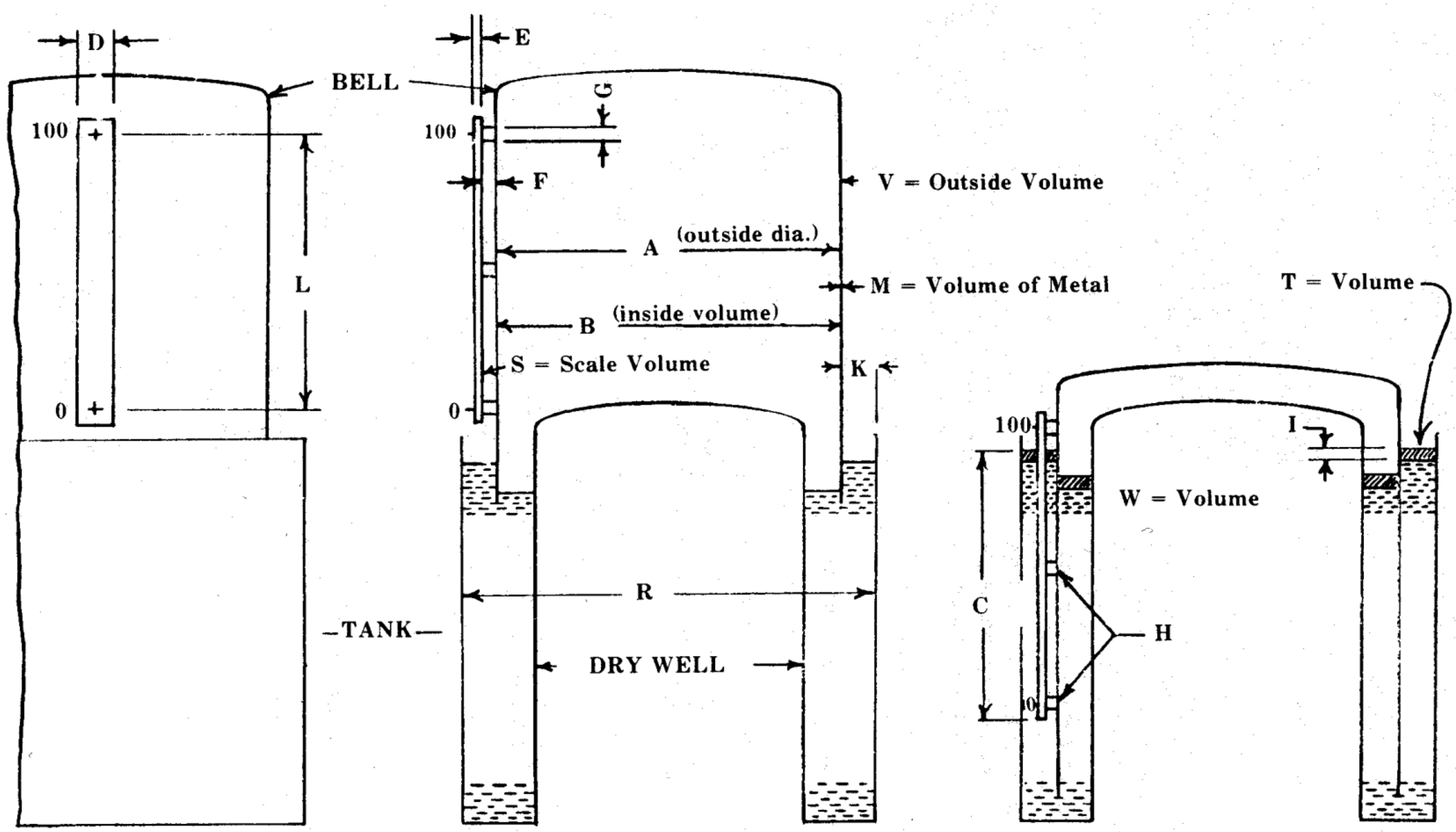


Figure E–1. Power bell calibration.

Determination of F, G, and H:

Measure scale button length and diameter and determine the number moving in and out of seal from zero to the point in question.

Determination of I:

a) With the bell set at scale zero (bell up for pressure proving), the seal level should be approximately 1/4 inch above the lower extremity of the machined tank flange. Regardless of the position of the bell, the seal should always remain within the constant diameter section of the well. Accurately measure the seal level from a stable reference point with depth micrometers. Generally this can be accomplished by resting the micrometer on the top of the machined tank flange.

b) Lower the bell to the desired scale length and remeasure the seal level.

c) Dimension I is the difference between the two readings.

d) Repeat as often as necessary to ensure repetitive results.

NOTE: Seal level measurement must be obtained at a constant bell pressure.

Determination of J:

Measure and calculate volume of any other appurtenances that move in and out of seal between zero and the point in question.

Determination of K:

With strapping tape, measure the I.D. of the tank at the machined section of the cast flange, keeping the tape flat and level. Subtract the thickness of the strapping tape. Subtract A from this measurement and divide by 2.

$$K = \frac{(\mathrm{I.D.\ of\ Tank} - \mathrm{A})}{2}$$

An alternative method would be to use an inside micrometer appropriate to the distance between the outside of the bell and the inside of the tank. Secure bell so that it cannot move and take four to six measurements of this distance at positions approximately equidistant around the circumference. Average these readings and add twice the result to the average diameter of the bell (see determination of A) thus:

$$R = A + 2K$$

Determination of L:

The length of the scale from zero to the point in question can be measured while on the bell using a cathetometer or by removing and measuring on a flat surface.

CALCULATIONS:

$$V = \frac{\pi A^2 L}{4} = \mathrm{in}^3$$

$$S = (C)(D)(E) + \frac{\pi(F)(G^2)(H)}{4} + J = \mathrm{in}^3$$

$$T = \frac{\pi I[(A + 2K)^2 - A^2]}{4} = \mathrm{in}^3$$

$$Q \text{ cubic inches} = V + S - T$$

$$Q \text{ cubic feet} = \frac{V + S - T}{1728}$$

If necessary, the actual “L” should be corrected proportionally to “Q.”

APPENDIX F
BAR CODE FOR METERS AND AUXILIARY DEVICES

(This Appendix is informative and is not part of the standard.)

TYPICAL FORMAT – GENERAL

INTRODUCTION: While there are several bar coding symbols available, this Appendix describes one that has been adopted by the National Electric Manufacturer Association (NEMA) for submission to the ANSI C-12 Committee.

Code:
Bar Code 39, using the 43 character ASCII set

Size and Type of Label:
2.3 inches long, 0.5-inches high

Printing Dimension and Format:
Code 39 bar code printed 9.4 characters per inch.
Bar 0.20-inches high.
Free Field Line 0.20-inches high.
Interpretation Line 0.1-inches high.

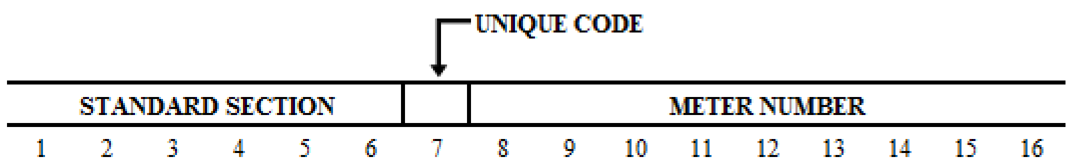
Number of Characters:
18 characters total, which are composed of 16 characters and two start-stop asterisks.

Number of lines on label: Three (3)
Line 1: Free text, specified by buyer's purchase order
Line2: Meter Information Line printed in Bar Code 39
Line 3: Bar Code Interpretation Line

Format of Meter Information:
See accompanying layout

BAR CODE FOR METERS AND AUXILIARY DEVICES
TYPICAL FORMAT OF INTERPRETATION LINE

I. Overall Layout



II. Layout of the standard section

Position	#of Char.	Description
1-3	3	Code - size, type (hard case, tin case, rotary or turbine)
4-6	3	Manufacturer

III. Layout of the unique code

Position 7 – Unique code is a randomly generated alpha character that insures the uniqueness of the meter number.

IV. Layout of the meter number.

Position	#of Char.	Description
8-16	9	Meter number - The meter number can either be the manufacturer's number or a Company assigned number.

FORM FOR PROPOSALS ON ANSI B109.2

Send to:
American Gas Association
ATTN: Secretariat B109
400 North Capitol Street, NW, Suite 450
Washington, DC 20001
U.S.A.
Fax: (202) 824-7082

Name____

Company____

Address____

Tel. No. ____________________ **Fax No.** ____________________

Please Indicate Organization Represented (if any)

____

1. Section/Paragraph

____

2. Proposal Recommends: (check one) ☐ **new text**
☐ **revised text**
☐ **deleted text**

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted, use separate sheet if needed): (Proposed text should be in legislative format; i.e., use underscore to denote wording to be inserted (<u>inserted wording</u>) and strike-through to denote wording to be deleted (~~deleted wording~~).

4. Statement of Problem and Substantiation for Proposal (use separate sheet if needed): (State the problem that will be resolved by your recommendation; give the specific reason for your proposal including copies of tests, research papers, etc.)

5. ☐ **This proposal is original material.** (Note: Original material is considered to be the submitter's own idea based on or as a result of his/her own experience, thought or research and, to the best of his/her knowledge, is not copied from another source.)

6. ☐ **This proposal is not original material; its source (if known) is as follows:**

____

Type or print legibly. If supplementary material (photographs, diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members of reviewing committees or task forces.

I hereby grant the American Gas Association the non-exclusive, royalty-free rights, including non-exclusive, royalty-free rights in copyright, in this proposal and I understand that I acquire no rights in any publication of the American Gas Association in which this proposal in this or another similar or analogous form is used.

Date:

____
Signature (Required)

FOR OFFICE USE ONLY

Log # ____________________

Date Rec'd ____________________