ANSI/AWWA C708-15
(Revision of ANSI/AWWA C708-11)

American Water Works Association
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AWWA Standard

Cold-Water Meters—Multijet Type

Effective date: Apr. 1, 2015.
First edition approved by AWWA Board of Directors Jan. 20, 1976.
This edition approved Jan. 24, 2015.
Approved by American National Standards Institute Oct. 16, 2014.

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Approved American National Standard ANSI

AWWA Standard

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ISBN-13, print: 978-1-62576-057-9
eISBN-13, electronic: 978-1-61300-319-0
DOI: http://dx.doi.org/10.12999/AWWA.C708.15

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Foreword

This foreword is for information only and is not a part of ANSI/AWWA C708.*

I. Introduction.

I.A. *Background.* For the past century, no tool available to water utilities has played a greater part in water conservation than the water meter. It has reduced waste and distributed the cost of operating a water system in the most equitable manner possible. Multijet meters, which were first designed and produced in 1867, have proved satisfactory for measuring domestic water service.

In inferential-type meters, the moving element is a rotor; the basic principle of this meter is to design it in such a manner that, over the working range of the instrument, the speed of rotation of the rotor bears a linear relationship to the velocity of flow through the meter.

In multijet meters, the moving element takes the form of a multiblade rotor mounted on a vertical spindle within a cylindrical measuring chamber. The liquid enters the measuring chamber through several tangential orifices around the circumference and leaves the measuring chamber through another set of tangential orifices placed at a different level in the measuring chamber.

I.B. *History.* Advances made in the development of nonmetallic materials for water meter construction have been recognized in the materials section of this standard. Several plastic materials are currently being used successfully for meter components. Several suitable plastic materials are included in this revision.

The first edition of the standard was approved by the AWWA Board of Directors on June 20, 1976. Subsequent editions of this standard were approved on Feb. 1, 1982; Jan. 27, 1991; June 23, 1996; Jan. 16, 2005; and June 12, 2011. This edition was approved on Jan. 24, 2015.

I.C. *Acceptance.* In May 1985, the US Environmental Protection Agency (USEPA) entered into a cooperative agreement with a consortium led by NSF International (NSF) to develop voluntary third-party consensus standards and a certification program for direct and indirect drinking water additives. Other members of the original consortium included the Water Research Foundation (formerly AwwaRF) and the Conference of State Health and Environmental Managers (COSHEM). The

* American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036.

American Water Works Association (AWWA) and the Association of State Drinking Water Administrators (ASDWA) joined later.

In the United States, authority to regulate products for use in, or in contact with, drinking water rests with individual states.* Local agencies may choose to impose requirements more stringent than those required by the state. To evaluate the health effects of products and drinking water additives from such products, state and local agencies may use various references, including

1. An advisory program formerly administered by USEPA, Office of Drinking Water, discontinued on Apr. 7, 1990.
2. Specific policies of the state or local agency.
3. Two standards developed under the direction of NSF†: NSF/ANSI 60, Drinking Water Treatment Chemicals—Health Effects, and NSF/ANSI 61, Drinking Water System Components—Health Effects.
4. Other references, including AWWA standards, *Food Chemicals Codex*, *Water Chemicals Codex*,‡ and other standards considered appropriate by the state or local agency.

Various certification organizations may be involved in certifying products in accordance with NSF/ANSI 61. Individual states or local agencies have authority to accept or accredit certification organizations within their jurisdictions. Accreditation of certification organizations may vary from jurisdiction to jurisdiction.

Annex A, "Toxicology Review and Evaluation Procedures," to NSF/ANSI 61 does not stipulate a maximum allowable level (MAL) of a contaminant for substances not regulated by a USEPA final maximum contaminant level (MCL). The MALs of an unspecified list of "unregulated contaminants" are based on toxicity testing guidelines (noncarcinogens) and risk characterization methodology (carcinogens). Use of Annex A procedures may not always be identical, depending on the certifier.

In an alternative approach to inadvertent drinking water additives, some jurisdictions (including California, Louisiana, Maryland, and Vermont, at the time of this writing) are calling for reduced lead limits for materials in contact with potable water. Various third-party certifiers have been assessing products against these lead content criteria, and a new ANSI-approved national standard, NSF/ANSI 372, Drinking Water System Components—Lead Content, was published in 2010.

* Persons outside the United States should contact the appropriate authority having jurisdiction.

† NSF International, 789 North Dixboro Road, Ann Arbor, MI 48105.

‡ Both publications available from National Academy of Sciences, 500 Fifth Street NW, Washington, DC 20001.

On Jan. 4, 2011, legislation was signed revising the definition for "lead free" within the Safe Drinking Water Act (SDWA) as it pertains to "pipe, pipe fittings, plumbing fittings, and fixtures." The changes went into effect on Jan. 4, 2014. In brief, the new provisions to the SDWA require that these products meet a weighted average lead content of not more than 0.25 percent.

ANSI/AWWA C708 does not address additives requirements. Users of this standard should consult the appropriate state or local agency having jurisdiction in order to

1. Determine additives requirements, including applicable standards.
2. Determine the status of certifications by parties offering to certify products for contact with, or treatment of, drinking water.
3. Determine current information on product certification.

II. Special Issues.

II.A. *Fire Flow.* The meters described in this standard are not designed to be used in water service piping intended to extinguish fire. Requirements for meters used for residential fire sprinkler applications that meet the requirements of NFPA* 13D in single- and two-family dwellings and manufactured homes, sizes ¾ in. (20 mm) through 2 in. (50 mm), are found in ANSI/AWWA C714.

III. Use of This Standard. It is the responsibility of the user of an AWWA standard to determine that the products described in that standard are suitable for use in the particular application being considered.

III.A. *Purchaser Options and Alternatives.* The following information should be provided by the purchaser:

1. Standard used—that is, ANSI/AWWA C708, Standard for Cold-Water Meters—Multijet Type, of latest revision.
2. Whether compliance with NSF/ANSI 61, Drinking Water System Components—Health Effects; NSF/ANSI 372, Drinking Water System Components—Lead Content; or an alternative lead content criterion is required.
3. If warranty requirements will be specified.
4. If the meter is to be read in US gallons, cubic feet, or cubic meters.
5. Details of other federal, state or provincial, and local requirements (Sec. 4.1).
6. If main casings are to be constructed of a copper alloy, stainless steel, or a suitable engineering plastic (Sec. 4.1.2).

* National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169.

7. If meters are to be provided with cast-iron, stainless-steel, copper-alloy, or suitable engineering plastic top or bottom covers (Sec. 4.1.11), and if there is a preference.

8. Size of meter (Sec. 4.2.1) and quantity required.

9. If corrosion protection is required, such as for cast-iron frost-protection covers (Sec. 4.2.6), and if there is a preference.

10. Modifications of test specifications (Sec. 4.2.8) if operating water temperatures will exceed 80°F (27°C) (Sec. A.4.2).

11. If 1½-in. (40-mm) and 2-in. (50-mm) meters (Sec. 4.3.3) are to be provided with flanged ends or threaded (spud) ends. If threaded (spud) ends are required, specify if threads are to be external NPSM or internal NPT.

12. If couplings (tailpieces) are to be provided with ⅝-in. (15-mm) to 2-in. (50-mm) meters (Sec. 4.3.4) and whether components are to be of a copper alloy, stainless steel, or a suitable engineering plastic (Sec. 4.1.9).

13. If companion flanges, gaskets, bolts, and nuts are to be provided with flanged meters (Sec. 4.3.5) and whether companion flanges are to be made of a copper alloy, cast iron, stainless steel, or a suitable engineering plastic (Sec. 4.1.10).

14. Details of the register to be provided (i.e., US gallons, cubic feet, or cubic meters; dry or wet register) (Sec. 4.3.6).

15. If a direct-reading remote register or an encoder-type remote register is required (Sec. 4.3.6.4), including specifications in detail, and including detailed warranty requirements as to battery life and compatibility with various radio frequency (RF) reading devices.

16. If the size of individual meters will be permanently marked on the register dial face (Sec. 6.1).

17. If an affidavit of compliance (Sec. 6.3) and certificate of testing for accuracy (Sec. A.2.3) are required.

18. Special materials required, if any, to resist corrosion if water is highly aggressive (Sec. A.4.3).

III.B. *Modification to Standard.* Any modification to the provisions, definitions, or terminology in this standard must be provided by the purchaser.

IV. Major Revisions. The major revisions to the standard in this edition include the following:

1. Foreword Sec. I.C provides information on lead content criteria and recent federal legislation revising the definition of "lead free" in the Safe Drinking Water Act.

2. Foreword Sec. II.A provides new information that meters used for residential fire sprinkler applications meeting the requirements of NFPA 13D, sizes ¾ in. (20 mm) through 2 in. (50 mm), are found in ANSI/AWWA C714.

3. In Section 3, the definition of "manufacturer" has been changed to include the party that supplies the product marked with its brand name.

4. In Section 4, the materials have been updated in response to legislation revising the definition of "lead free" in the Safe Drinking Water Act. Stainless steel has been added as a material for measuring cages or chambers (Sec. 4.1.4) and companion flanges (Sec. 4.1.10).

5. Sec. 4.3.6 on registers has been updated to include requirements for electronic display registers.

6. Editorial clarifications have been provided throughout the standard.

V. Comments. If you have any comments or questions about this standard, please call AWWA Engineering and Technical Support at 303.794.7711, FAX at 303.795.7603; write to the department at 6666 West Quincy Avenue, Denver, CO 80235-3098; or email at standards@awwa.org.

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AWWA Standard

Cold-Water Meters—Multijet Type

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes cold-water multijet meters in sizes ⅝ in. (15 mm) through 2 in. (50 mm) for water utilities' customer service and the materials and workmanship employed in their fabrication. These meters register by recording the revolutions of a rotor set in motion by the force of flowing water striking the blades.

Sec. 1.2 Purpose

The purpose of this standard is to provide the minimum requirements for multijet-type cold-water meters, including materials and design.

Sec. 1.3 Application

This standard can be referenced in specifications for purchasing and receiving cold-water meters—multijet type. This standard can be used for manufacturing this type of meter. The stipulations of this standard apply when this document has been referenced and then only to cold-water meters—multijet type.

SECTION 2: REFERENCES

This standard references the following documents. In their latest editions, they form a part of this standard to the extent specified within the standard. In any case of conflict, the requirements of this standard shall prevail.

ANSI*/AWWA C706—Direct-Reading, Remote-Registration Systems for Cold-Water Meters.

ANSI/AWWA C707—Encoder-Type Remote-Registration Systems for Cold-Water Meters.

ASME† B1.20.1—Pipe Threads, General Purpose, Inch, Table 6, Dimensions of External and Internal Straight Pipe Threads for Fixtures (NPSM).

ASTM‡ A48—Standard Specification for Gray Iron Castings.

ASTM A126—Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

ASTM A159—Standard Specification for Automotive Gray Iron Castings.

ASTM A167—Standard Specification for Stainless and Heat-Resisting Chromium–Nickel Steel Plate, Sheet, and Strip.

ASTM A276—Standard Specification for Stainless Steel Bars and Shapes.

ASTM A351—Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.

ASTM A493—Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.

ASTM A582/A582M—Standard Specification for Free-Machining Stainless Steel Bars.

ASTM B16—Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.

ASTM B36/B36M—Standard Specification for Brass Plate, Sheet, Strip, and Rolled Bar.

ASTM B98—Standard Specification for Copper–Silicon Alloy Rod, Bar, and Shapes.

ASTM B139—Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.

ASTM B164—Standard Specification for Nickel–Copper Alloy Rod, Bar, and Wire.

ASTM B176—Standard Specification for Copper-Alloy Die Castings.

* American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036.
† ASME International, 3 Park Avenue, New York, NY 10016.
‡ ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

ASTM B584—Standard Specification for Copper Alloy Sand Castings for General Applications.

ASTM D1248—Standard Specification for Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable.

ASTM D3935—Standard Specification for Polycarbonate (PC) Unfilled and Reinforced Material.

ASTM D4066—Standard Specification for Nylon Injection and Extrusion Materials (PA).

ASTM D4067—Standard Specification for Reinforced and Filled Polyphenylene Sulfide (PPS) Injection Molding and Extrusion Materials.

ASTM D4181—Standard Specification for Acetal (POM) Molding and Extrusion Materials.

ASTM D4349—Standard Specification for Polyphenylene Ether (PPE) Materials.

ASTM D4549—Standard Specification for Polystyrene and Rubber-Modified Polystyrene Molding and Extrusion Materials (PS).

ASTM F467—Standard Specification for Nonferrous Nuts for General Use.

ASTM F468—Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.

AWWA Manual M6, *Water Meters—Selection, Installation, Testing, and Maintenance*.

SECTION 3: DEFINITIONS

The following definitions shall apply in this standard:

1. *Manufacturer:* The party that manufactures, fabricates, or produces materials or products, or supplies the product marked with its brand name.
2. *Purchaser:* The person, company, or organization that purchases any materials or work to be performed.
3. *Supplier:* The party that supplies materials or services. A supplier may or may not be the manufacturer.

SECTION 4: REQUIREMENTS

Sec. 4.1 Materials*

Materials shall comply with the requirements of the Safe Drinking Water Act and other federal requirements.

4.1.1 *General.* Materials used in the manufacture of water meters shall conform to the requirements stipulated in the following section. Where plastic materials are allowed, the manufacturer may provide any plastic materials that meet the performance requirements specified; typical examples are provided.

4.1.1.1 Materials† shall be selected for their strength and resistance to corrosion and shall not impart to the water objectionable taste or odor, nor toxic substances in normalized concentrations exceeding the maximum contaminant levels (MCLs) as defined by the US Environmental Protection Agency (USEPA).

If engineering plastic materials are used, only virgin, or first-generation–grade, rigid engineering plastic materials shall be used in the manufacture of the main casings, covers, and bottoms; these engineering plastic materials shall be compounded with ultraviolet stabilizers.

4.1.2 *Main casings.* Main casings shall be made of a copper alloy containing not less than 75 percent copper, such as UNS C89510, C89520, C89833, or C89836, or a similar copper alloy as listed in ASTM B584; or a cast austenitic stainless steel as listed in ASTM A351; or a suitable engineering plastic such as polycarbonate (PC) in accordance with ASTM D3935, polyphenylene ether (PPE) in accordance with ASTM D4349, or nylon (PA) in accordance with ASTM D4066.

Materials used in the construction of meter main cases shall have sufficient dimensional stability to retain operating clearances at working temperatures of up to 105°F (40°C) and shall not permanently warp or deform when exposed to temperatures of up to 150°F (66°C) for 1 hr.

4.1.3 *Register-box rings and lids.* Register-box rings and lids shall be made of a copper alloy containing not less than 57 percent copper, such as UNS C85700 or UNS C86200, or a similar copper alloy as listed in ASTM B584, or UNS C85800 as listed in ASTM B176; or a suitable engineering plastic, such as polycarbonate (PC) in accordance with ASTM D3935, polystyrene in accordance with

* The composition of alloys in the section are subject to commercially accepted tolerances.
† The US Safe Drinking Water Act limits the lead content in materials used for wetted-pipe fittings.

ASTM D4549, acetal in accordance with ASTM D4181, or nylon (PA) in accordance with ASTM D4066.

Materials used in the construction of register-box rings and lids shall have sufficient dimensional stability to retain operating clearances at working temperatures of up to 105°F (40°C) and shall not permanently warp or deform when exposed to temperatures of up to 150°F (66°C) for 1 hr.

4.1.4 *Measuring cages or chambers.* Measuring cages or chambers shall be made of a copper alloy containing not less than 85 percent copper, such as UNS C89510, C89520, C89833, or C89836, or a similar copper alloy as listed in ASTM B584; or a cast austenitic stainless steel as listed in ASTM A351; or a suitable engineering plastic, such as polyphenylene ether (PPE) in accordance with ASTM D4349, nylon (PA) in accordance with ASTM D4066, polyethylene in accordance with ASTM D1248, or polystyrene in accordance with ASTM D4549.

Measuring cages or chambers shall have sufficient dimensional stability to retain operating clearances at working temperatures of up to 80°F (27°C) and shall not warp or deform when exposed to operating temperatures of 100°F (38°C).

4.1.5 *Measuring rotors.* A rotor shall be made of a suitable engineering plastic having sufficient rigidity and strength to operate at the rated capacity of the meter, such as polystyrene in accordance with ASTM D4549, polyphenylene sulfide (PPS) in accordance with ASTM D4067, or nylon (PA) in accordance with ASTM D4066.

Rotors shall have sufficient dimensional stability to retain operating clearances at working temperatures of up to 80°F (27°C) and shall not warp or deform when exposed to operating temperatures of 100°F (38°C).

4.1.6 *Rotor spindles.* Rotor spindles shall be made of phosphor bronze in accordance with ASTM B139; one of the austenitic stainless steels listed in ASTM A276; nickel–monel alloys in accordance with ASTM B164; or rigid thermoplastic compounds, such as acetal resin in accordance with ASTM D4181, polycarbonate (PC) in accordance with ASTM D3935, or polyphenylene sulfide (PPS) in accordance with ASTM D4067.

Rotor spindles shall have sufficient dimensional stability to retain operating clearances at working temperatures of up to 80°F (27°C) and shall not warp or deform when exposed to operating temperatures of 100°F (38°C).

4.1.7 *Register gear trains.* Frames, gears, and pinions of intermediate gear trains exposed to water shall be made of a copper alloy, such as listed in ASTM B16, ASTM B36, and ASTM B98; stainless steels of either the austenitic or martensitic types listed in ASTM A276 or ASTM A582; or a suitable engineering plastic, such as polyethylene in accordance with ASTM D1248, polystyrene in accordance with ASTM D4549, nylon (PA) in accordance with ASTM D4066, or acetal in accordance with ASTM D4181. If not exposed to water, gear trains may also be made of other suitable materials in accordance with reference standards.

Frames, gears, and pinions of intermediate gear trains exposed to water shall have sufficient dimensional stability to retain operating clearances at working temperatures of up to 80°F (27°C) and shall not warp or deform when exposed to operating temperatures of 100°F (38°C).

4.1.8 *External-case closure fasteners.* External fasteners shall be made of a copper alloy containing not less than 57 percent copper, such as a brass alloy UNS C27200 as listed in ASTM B36; a silicon–bronze alloy as listed in ASTM B98; any of the copper-based alloys specified for general fastener use as listed in ASTM F467 or ASTM F468; or stainless steels of the austenitic, ferritic, or martensitic types listed in ASTM A276, ASTM A493, and ASTM A582.

Fasteners for nonpressure containment assemblies may be made of a suitable engineering plastic such as polycarbonate (PC) in accordance with ASTM D3935, nylon (PA) in accordance with ASTM D4066, or acetal in accordance with ASTM D4181; or any of the aforementioned copper-based or stainless-steel materials.

4.1.9 *Coupling tailpieces and nuts.* Coupling tailpieces and nuts shall be made of a copper alloy containing not less than 75 percent copper, such as UNS C84400 or C93200 for nuts and such as UNS C89510, C89520, C89833, or C89836 for tailpieces, or a similar copper alloy as listed in ASTM B584; or, when specified by the purchaser, of a suitable virgin-grade engineering plastic, such as PC in accordance with ASTM D3935, PA in accordance with ASTM D4066, or PPS in accordance with ASTM D4067.

4.1.10 *Companion flanges.* Companion flanges shall be made of cast iron, such as listed in ASTM A48, ASTM A126, or ASTM A159; or when specified by the purchaser, of a copper alloy containing not less than 75 percent copper, such as UNS C89510, C89520, C89833, or C89836, or a similar copper alloy as listed in ASTM B584; or a cast austenitic stainless steel as listed in ASTM A351; or a suitable virgin-grade engineering plastic.

4.1.11 *Covers, top or bottom.* Engineering plastic covers, top or bottom, shall have sufficient dimensional stability to retain operating clearances at working temperatures of up to 105°F (40°C) and shall not permanently warp or deform when exposed to temperatures of up to 150°F (66°C) for 1 hr. Breakable and nonbreakable top or bottom covers shall be as follows.

4.1.11.1 Breakable. Breakable covers (frost-protection devices) shall be made of a cast iron, such as listed in ASTM A48, ASTM A126, or ASTM A159; or austenitic stainless steel, such as listed in ASTM A167; a copper alloy containing not less than 75 percent copper, such as UNS C89510, C89520, C89833, C89836, or a similar copper alloy as listed in ASTM B584; or a suitable engineering plastic, such as polyphenylene sulfide (PPS) in accordance with ASTM D4067, nylon (PA) in accordance with ASTM D4066, polycarbonate (PC) in accordance with ASTM D3935, or acetal in accordance with ANSI/ASTM D4181. The design and composition of such components will satisfy the break or yield requirements set forth in Sec. 4.2.5. Meters equipped with frost-protection devices can cause flooding to occur because of frost-protection devices yielding or fracturing, as indicated in AWWA Manual M6.

4.1.11.2 Nonbreakable. Nonbreakable covers shall be made of austenitic stainless steel, such as listed in ASTM A167; a copper alloy containing not less than 75 percent copper, such as UNS C89510, C89520, C89833, C89836, or a similar copper alloy as listed in ASTM B584; or a suitable engineering plastic, such as polyphenylene sulfide (PPS) in accordance with ASTM D4067, nylon (PA) in accordance with ASTM D4066, polycarbonate (PC) in accordance with ASTM D3935, or acetal in accordance with ASTM D4181. The design and composition of such components will satisfy the break or yield requirements set forth in Sec. 4.2.5.

Sec. 4.2 General Design

4.2.1 *Size.* The operating and physical characteristics listed in Table 1 and Table 2 shall determine the nominal size of meters.

4.2.2 *Capacity.* The nominal capacity ratings and the related pressure loss limits shall be the same as those listed in Table 1 for the safe maximum operating capacities.

4.2.3 *Length.* The lengths of the meters shall be the face-to-face dimensions of spuds or flanges and shall be those listed in Table 2.

4.2.4 *Pressure requirement.* Meters supplied in accordance with this standard shall operate without leakage or damage to any part at a continuous working pressure of 150 psi (1,050 kPa).

Table 1 Operating characteristics

Meter Size*		Safe Maximum Operating Capacity†		Maximum Pressure Loss at Safe Maximum Operating Capacity		Recommended Maximum Rate for Continuous Operations‡		Minimum Test Flow§		Normal Test-Flow Limits§	
in.	*(mm)*	*gpm*	*(m³/h)*	*psi*	*(kPa)*	*gpm*	*(m³/h)*	*gpm*	*(m³/h)*	*gpm*	*(m³/h)*
⅝	(15)	20	(4.5)	15	(103)	10	(2.3)	¼	(0.06)	1–20	(0.2–4.5)
⅝ × ¾	(15 × 20)	20	(4.5)	15	(103)	10	(2.3)	¼	(0.06)	1–20	(0.2–4.5)
¾	(20)	30	(6.8)	15	(103)	15	(3.4)	½	(0.11)	2–30	(0.5–6.8)
1	(25)	50	(11.4)	15	(103)	25	(5.7)	¾	(0.17)	3–50	(0.7–11.4)
1½	(40)	100	(22.7)	15	(103)	50	(11.3)	1½	(0.34)	5–100	(1.1–22.7)
2	(50)	160	(36.3)	15	(103)	80	(18.1)	2	(0.45)	8–160	(1.8–36.3)

* Metric conversions given in this standard may be either rounded or direct conversions of US customary units and may or may not be those specified in other international standards.
† Operation at this flow rate should not exceed 10 percent of usage, or 2 hr in a 24-hr period.
‡ See Sec. A.4.1.
§ See Sec. 4.2.8.

Table 2 Physical characteristics

Meter Size†		Meter Length				Meter Casing Spuds*	Coupling (Tailpieces)		
		Screw Ends		Flange Ends		Nominal Thread Size	Length		Nominal Thread Size
in.	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*	*in.*	*in.*	*(mm)*	*in.*
⅝	(15)	7½	(190)	—	—	¾	2⅜	(60.3)	½
⅝ × ¾	(15 × 20)	7½	(190)	—	—	1	2½	(64.0)	¾
¾	(20)	9	(229)	—	—	1	2½	(64.0)	¾
1	(25)	10¾	(273)	—	—	1¼	2⅝	(67.0)	1
1½	(40)	12⅝	(321)	13	(330)	2	2⅞	(73.0)	1½
1½	(40)	—	—	—	—	1½‡	—	—	—
2	(50)	15¼	(387)	17	(432)	2½	3	(76.2)	2
2	(50)	—	—	—	—	2‡	—	—	—

* See Sec. 4.3.3.2 for additional information on meter casing spuds.
† Metric conversions given in this standard may be either rounded or direct conversions of US customary units and may or may not be those specified in other international standards.
‡ Internal threaded spuds.

4.2.5 *Plastic meter pressure casing, cover, and bottom design.* The design of the plastic meter pressure casings, covers, and bottoms shall meet the following requirements:

4.2.5.1 Yield strength. Pressure casings, covers, and bottoms shall be designed to be watertight and capable of withstanding, without exceeding the yield strength of the material or being structurally damaged, a hydrostatic pressure of two times the rated maximum working pressure (300 psi [2,100 kPa] minimum) for a period of 15 min.

4.2.5.2 Burst pressure. Nonbreakable pressure casings, covers, and bottoms shall be designed to withstand a burst pressure of at least four times the rated maximum working line pressure (600 psi [4,200 kPa] minimum). Breakable covers and bottoms shall be designed to have a burst pressure of at least three times the rated maximum working line pressure (450 psi [3,100 kPa]). Components shall be watertight at 150 psi (1,050 kPa) after being subjected to a minimum of 100,000 pressure cycles of 100 to 300 psi (700 to 2,100 kPa) in 1.5 sec and a hold time of 1 min, followed by an immediate release of pressure to the 100-psi (700-kPa) lower limit.

4.2.6 *Frost-protection devices.* Frost-protection devices, when provided, shall be of such design that they will yield or break under normal freezing conditions in order to minimize damage to any other parts of the meter. On the top or bottom covers, the internal portion, designed to afford frost protection, may be protected from corrosion by an inner lining or coating that is suitable for contact with potable water.

WARNING: Meters equipped with frost-protection devices can cause flooding to occur because of frost-protection devices yielding or fracturing, as indicated in AWWA Manual M6.

4.2.7 *Accessibility.* Meters larger than 1 in. (25 mm) shall be designed to allow for easy removal of interior parts without disturbing the connections to the pipeline. A tubular strainer, when placed at the meter inlet spud, shall be excluded from this requirement.

4.2.8 *Registration accuracy.* Meters shall meet the following requirements for accuracy with water at a temperature lower than 80°F (27°C).

4.2.8.1 Normal flow limits. At any rate of flow within the normal test-flow limits set forth in Table 1, the meter shall register not less than 98.5 percent and not more than 101.5 percent of the water that actually passes through it.

4.2.8.2 Minimum flow rate. From the minimum test-flow rate to the lowest normal test-flow rate set forth in Table 1, the meter shall register not less than 97 percent and not more than 103 percent of the water that actually passes through it.

4.2.9 *Calibration adjustment.* Multijet-type meters may be fitted with a means of altering the flow–rotor speed relationship. If external to the meter, a method of sealing must be provided.

Sec. 4.3 Detailed Design

4.3.1 *Main case.* Each meter shall have an outer case with a separate, removable measuring chamber or cage in which the rotor operates. Cases shall not be repaired in any manner. The inlet and outlet of the main case shall have a common axis. Connection flanges shall be parallel.

4.3.2 *External-case fasteners and seals.* External fasteners and seals shall be designed for easy disassembly following lengthy service without the use of special tools or equipment.

4.3.3 *Connections.* Main-case connections for 1½-in. (40-mm) and 2-in. (50-mm) meters shall be either spuds on both ends or flanges on both ends, as required by the purchaser.

4.3.3.1 Casing spuds. Casing spuds for ⅝-in. (15-mm), ⅝-in. × ¾-in. (15-mm × 20-mm), ¾-in. (20-mm), and 1-in. (25-mm) meters shall have external straight threads (NPSM) conforming to ASME B1.20.1.

4.3.3.2 Casing spuds for intermediate-sized meters. Casing spuds for 1½-in. (40-mm) and 2-in. (50-mm) meter models shall have either external straight threads (NPSM) conforming to ASME B1.20.1 or internal-taper pipe threads (NPT) (of a 1½-in. [40-mm] or 2-in. [50-mm] size, respectively) conforming to ASME B1.20.1.

4.3.3.3 Casing flanges. Casing flanges for 1½-in. (40-mm) and 2-in. (50-mm) meters shall be faced and drilled and shall be the oval type. The drilling shall be on the horizontal axis. The number of bolt-holes and the diameter of the bolt-holes and bolt-hole circle shall be as listed for companion flanges in Table 3.

4.3.4 *Meter couplings (tailpieces).* Meter couplings shall be provided if required by the purchaser.

4.3.5 *Companion flanges.* Companion flanges, gaskets, bolts, and nuts shall be provided if required by the purchaser. Companion flanges shall be tapped, 1½ in. (40 mm) or 2 in. (50 mm), as required, with internal-taper pipe thread (NPT) as specified in ASME B1.20.1. Dimensions shall be those listed in Table 3.

Table 3 Flange dimensions

Meter Size*		Diameter Bolt-Hole Circle		Number of Bolt-Holes	Minimum Diameter Bolt-Holes		Minimum Thickness at Bolt-Hole		Minimum Thickness at Hub	
in.	*(mm)*	*in.*	*(mm)*		*in.*	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*
1½ (flange, oval)	(40)	4	(102)	2	11⁄16	(17.5)	9⁄16	(14.3)	13⁄16	(20.6)
2 (flange, oval)	(50)	4½	(114)	2	¾	(19)	⅝	(15.9)	⅞	(22.2)

* Metric conversions given in this standard may be either rounded or direct conversions of US customary units and may or may not be those specified in other international standards.

4.3.6 *Registers.* Registers shall be straight reading, shall be permanently sealed by the manufacturer or have replaceable change gears, and shall read in US gallons, cubic feet, or cubic meters, as specified by the purchaser.

As specified by the purchaser, the register shall be a mechanical display–type register or an electronic display–type register. Mechanical display–type registers may be either the dry type or wet type.

4.3.6.1 Mechanical display–type registers. If a mechanical display–type register is provided, the register shall meet the following requirements.

4.3.6.1.1 For the dry-type register, the permanently sealed dry-type register shall be encased in a metal and glass enclosure and the register's internal components shall not be in contact with the water being measured. Provisions to adapt remote-type registers (see foreword, Sec. III.A.15; and Sec. 4.3.6.4) to the meters may require the use of suitable engineering plastic materials.

4.3.6.1.2 For the wet-type register, the register may be in contact with the water being measured.

4.3.6.1.3 Number wheel numerals. The numerals on the number wheels of straight-reading registers should be not less than 5⁄32 in. (4 mm) in height and should be readable at a 45° angle from the vertical.

4.3.6.1.4 Maximum and minimum indications. The maximum indication of the digits appearing on the first number wheel and the minimum capacity of the register shall be those listed in Table 4.

4.3.6.1.5 Test hands. Registers shall be provided with either a center-sweep test hand or test index circles, and shall meet the following requirements:

Table 4 Maximum indication on initial dial and minimum register capacity

Meter Size		Maximum Allowable Indication of Initial Dial			Minimum Allowable Capacity of Register (Millions)		
in.	*(mm)*	*ft*³	*gal*	*m*³	*ft*³	*gal*	*m*³
⅝	(15)	1	10	0.1	0.1	1	0.01
⅝ × ¾	(15 × 20)	1	10	0.1	0.1	1	0.01
¾	(20)	1	10	0.1	1	10	0.1
1	(25)	10	100	1	1	10	0.1
1½	(40)	10	100	1	10	100	1
2	(50)	10	100	1	10	100	1

1. If registers are provided with test index circles, the test index circles shall be divided into 10 equal parts. For the initial test index circle, each division should represent no more than 1⁄100 of the initial-dial indication given in Table 4. The hand or pointer shall taper to a sharp point and shall be set accurately and held securely in place.

2. If the register is provided with a center-sweep test hand, there shall be an index circle located around the periphery of the register and graduated in 100 equal parts, with each tenth graduation numbered. The hand or pointer shall taper to a point and shall be accurately set and securely held in place. The quantity indicated by a single revolution of the test hand shall be those listed in Table 4 for initial-dial indication.

4.3.6.1.6 Standard straight-reading register. The register shall be of the center-sweep test-hand type, with the test circle located on the periphery of the register and graduated in 100 equal parts, with each tenth graduation numbered. Register construction shall conform to all applicable requirements of Sec. 4.3.6.

4.3.6.1.7 Register colors. The register test hand shall be red. The register number wheels shall be black and white. The register face on meters for potable water shall be white. The register face on meters for reclaimed water shall be lavender.

4.3.6.2 Electronic display registers. If an electronic display register is provided, the register shall meet the following requirements:

4.3.6.2.1 The electronic display register digits shall not be less than 5⁄32 in. (4 mm) in height and shall be readable at a 45° angle from the vertical position.

4.3.6.2.2 For the purposes of meter testing, the electronic display register shall be capable of directly displaying 1⁄1,000 of the value listed in the initial dial in Table 4.

4.3.6.2.3 The totalized consumption shall be displayed with leading zeros so that all digits capable of displaying are readable.

4.3.6.2.4 The delimiter in the totalized display shall be in the form of a period (.) or comma (,).

4.3.6.2.5 The electronic display register shall clearly distinguish digits used for customary billing units.

4.3.6.2.6 The electronic display register shall be straight reading and shall read in US gallons, cubic feet, or cubic meters, as required by the purchaser.

4.3.6.2.7 The electronic display register shall be permanently sealed so that moisture does not impede the register's operation and readability.

4.3.6.2.8 If a battery is used as the primary power source, the electronic display register shall provide indication of low battery voltage and shall be designed to provide at least 180 days of useful life from the initial low-battery-voltage indication to the end of the battery's life.

4.3.6.2.9 If rate of flow is part of the register's functionality, the electronic display register shall meet the following additional requirements:

1. The display shall be capable of toggling between totalized flow and flow rate if the same digits are used.

2. The display shall have indication to clearly designate when the display is in rate mode.

3. The display shall be capable of providing flow rate information—volume (US gallons, cubic feet, or cubic meters) per unit time (per second, per minute, or per hour)—in the purchaser's preferred units of measurement, as required by the purchaser.

4.3.6.2.10 Other alarm indicators, such as "reverse flow," "backflow," "flow direction," or "leak," may be displayed as required by the purchaser.

4.3.6.3 Register boxes. The name of the manufacturer shall be permanently marked on the lid of the register box. The serial number of the meter shall be on the lid. The lid shall be recessed and shall overlap the register box to protect the lens, and the lens shall be held securely in place.

4.3.6.4 Remote registers. If specified by the purchaser, provisions shall be made to adapt a direct-reading remote-type register (ANSI/AWWA C706) or encoder-type remote register (ANSI/AWWA C707).

4.3.7 *Measuring chambers or cages.* The measuring chambers or cages shall be self-contained units firmly seated and easily detached and removed from the main case. Measuring chambers or cages shall be secured in the main case so that the accuracy of the meter will not be affected by any distortion of the main case that might occur when operating with a pressure of less than 150 psi (1,050 kPa).

4.3.8 *Strainers.* Meters shall be provided with strainer screens installed in the meters. Strainer screens shall be rigid, snug-fitting, and easy to remove and shall have an effective straining area of at least double that of the main-case inlet.

4.3.9 *Tamper-resistant features.* Register-box retainers, external regulation devices, and coupling nuts, if provided, shall be equipped with tamper-resistant features. If the purchaser specifies coupling nuts with seal wires as a tamper-resistant feature, coupling nuts shall have seal-wire holes no smaller than 3⁄32 in. (2.4 mm) in diameter.

SECTION 5: VERIFICATION

Sec. 5.1 Basis for Rejection

Meters not complying with requirements of this standard shall be rejected. The manufacturer shall replace or satisfactorily correct meters rejected for failure to comply with this standard.

SECTION 6: DELIVERY

Sec. 6.1 Marking

The size, model, and the direction of flow through the meter shall be marked permanently on the outer case. The size (or sizes) of the meter shall be marked permanently on the register dial face. The manufacturer's meter serial number shall be marked permanently on the outer case if required by the purchaser.

6.1.1 *Register-box marking.* The name of the manufacturer shall be marked permanently in the lid of the register box. The serial number of the meter shall be imprinted on the lid.

Sec. 6.2 Packaging and Shipping

This standard has no applicable information for this section.

Sec. 6.3 Affidavit of Compliance

The purchaser may require the manufacturer to provide an affidavit attesting that the meters provided comply with all applicable requirements of this standard.

APPENDIX A

Supplemental Information

This appendix is for information only and is not a part of ANSI/AWWA C708.

SECTION A.1: UNITS OF MEASURE

The majority of water meters presently in service in the United States register in either US gallons or cubic feet. With the availability of the metric system, the user may determine the most suitable unit of measure from the three available units—US gallons, cubic feet, or cubic meters.

SECTION A.2: TESTS

Sec. A.2.1 Capacity and Pressure-Loss Tests

Capacity tests are tests of the design of a meter. Once a meter of each size of a given design has been tested for pressure loss at safe maximum operating capacity, it should not be necessary to test others of the same design.

The pressure loss should be determined by use of two identical piezometer rings of the same diameter as the nominal size of the meter being tested. The piezometer rings must be free from any burrs where the holes are drilled through the wall of the ring. No fewer than four holes should be provided, drilled in pairs on diameters at right angles to each other. The inlet ring should be set close to the meter at a distance of 8 diameters or more below the nearest upstream stop valve or fitting. The outlet ring should be placed at a distance of 8 to 10 diameters from the outlet of the meter. The diameter of the inlet and outlet pipes should be the same as the nominal size of the meter to be tested. The rings are to be connected to a suitable differential pressure (DP) cell or manometer with measurement capability of 0.1 psi (0.7 kPa). If a manometer is used, provisions should be made for the complete removal of air from the apparatus, and the installation should be such that air will rise to the air outlets.

Provisions must be made for traps to prevent accidental expulsion of mercury into the test line when using mercury manometers. If measurements of U-tube manometers are to be made at relatively high flow rates, it is necessary to read both sides of the manometer column simultaneously to compensate for irregularities in the diameter of the manometer U-tube and to avoid errors caused by fluctuations. NOTE: Other appropriate types of manometers may be used. The pressure loss of inlet and outlet piping from meter to piezometer rings shall be deducted in determining meter pressure loss.

Sec. A.2.2 Pressure Tests

A pressure test should be made on each size of a particular design of meter provided. The test pressure should be 300 psi (2,100 kPa) static, which may be produced by use of a hand pump or any other available device. The meter should be tested for accuracy before and after it has been pressure-tested to determine if there has been any distortion that could affect the registration. If satisfactory results are obtained, it is unnecessary to perform more than one pressure test on each size of a given design of meter.

Sec. A.2.3 Accuracy Tests

All meters should be tested for accuracy of registration at flow rates and test-flow quantities in accordance with Sec. 4.2.8 of ANSI/AWWA C708 and AWWA Manual M6. If the purchaser does not have suitable means for testing, the manufacturer should be requested to provide a certificate showing that each meter has been tested for accuracy of registration and that it complies with accuracy and capacity requirements of ANSI/AWWA C708.

Sec. A.2.4 Testing Multijet Meters

Some multijet meters may possibly give erroneous meter readings when subjected to multiple testing on the conventional test bench. As with all water meter testing, provisions must be made for removing entrained air ahead of the meters. Efforts should also be made to remove air trapped in the meters during their installation on the test bench. When two or more meters are tested simultaneously, the space between meters should be at least five diameters to avoid false readings caused by uneven flow disturbances. Test equipment should provide full-bore diameter for each meter size, and a constant flow stream free of disturbances should be provided. Test equipment should include provisions for the isolation of pumps that cause conventional test benches to vibrate, which may cause multijet meters to give erroneous meter readings. Care should be taken to ensure other pulsating meter types, such as positive displacement meters, which distribute their vibration effects downstream and can cause multijet meters to give erroneous meter readings, are not tested upstream of multijet meters.

SECTION A.3: TESTING EQUIPMENT

The measuring device used to determine the amount of water discharged in testing should be designed to provide accuracy to within 0.25 percent of the actual quantity. Tanks and scales should be tested and calibrated at least once a year and records kept of such tests and calibrations.

SECTION A.4: REGISTRATION ACCURACY

In a multijet-type meter, the motion of the measuring element (rotor) is transmitted by a system of gearing to the register, which records the flow in convenient units of measure. The gearing translates the motion of the element into the unit of measure indicated by the register. The registration is thus directly dependent on the number of revolutions of the element. The registration is a true measure of flow only when the meter has been properly calibrated. After proper calibration, the meter will continue to register correctly only so long as the element continues to make the required number of cycles for each unit of quantity passed through the meter. If any condition should develop whereby the element is compelled to make other than the required number of cycles per unit of quantity passed through the meter, the registration will be inaccurate. Under ordinary working conditions, several factors may cause inaccurate registration after comparatively short intervals. The most important of these factors are excessive wear, extreme temperatures, corrosion, material in suspension, and the presence of entrained air in the lines.

Sec. A.4.1 Excessive Wear

Excessive wear of the moving parts of the meter may be caused by improper setting or by overspeeding because the meter used is too small for the water demand. The results of excessive wear are slippage and underregistration. Excessive wear in the register-reduction gearing may cause the gears to slip or to bind. In either case, if the meter does not stop entirely, underregistration will result. To avoid excessive wear, it is recommended that meters be installed in a horizontal position and that meters should not be operated at excessive speeds. The safe maximum operating capacities listed in Table 1 of ANSI/AWWA C708 are the maximum rates of flow at which water should be passed through the meter. The maximum rate should extend only for short periods of time and at infrequent intervals. Maximum flow could be destructive if continuous. For continuous 24-hr service, multijet-type meters should not be operated at flows greater than approximately one-half of the safe maximum operating capacities as listed in Table 1 of ANSI/AWWA C708.

Sec. A.4.2 Temperature Extremes

The accuracy of multijet meters is not affected by temperatures up to 80°F (27°C). The accuracy limits set forth in Sec. 4.2.8 of ANSI/AWWA C708 may have to be modified for temperatures higher than 80°F (27°C). High temperatures can cause expansion of rotors and create unusual friction or binding. The result is slippage and underregistration or complete stoppage of the meter. These conditions can also occur where sudden maximum flow occurs and the magnetic coupling with the register fails. Lower temperatures have no noticeable effect on the working parts of the meter unless the water freezes, which will cause damage to the meter. To avoid troubles caused by temperature extremes, meters should be located where they will be protected from heat, direct sunlight, and freezing.

If the authority having jurisdiction so requires, at locations where hot water from heating systems is not allowed to expand back through the meter, a backflow-prevention device consistent with the degree of hazard and a pressure- and temperature-relief valve should be installed sufficiently downstream of the meter.

Sec. A.4.3 Corrosion

All the metals used in the construction of a meter are affected by the corrosive action of water, although the action is very slow with most potable waters. It should be recognized, however, that when meters are used in highly aggressive waters, it may be necessary to use materials that are more resistant to corrosive attack. A high degree of experience and knowledge is required to solve corrosion problems, and the manufacturer should be consulted for assistance.

Sec. A.4.4 Materials in Suspension

Foreign material carried in suspension has a tendency to deposit on the rotor and other parts of the meter, thus affecting registration. Meters provided with strainers will retain the larger particles in suspension, but the strainer will soon become clogged if the water is not kept reasonably free from suspended matter. Sand is especially destructive, and care should be exercised to prevent sand from reaching the meters.

Sec. A.4.5 Entrained Air

Entrained air in water lines will result in inaccurate registration of the meter. This inaccuracy can result in a substantial overregistration under certain circumstances. In addition, entrained air can cause meter damage and premature wear; precautions should be taken to either eliminate or minimize this condition.

SECTION A.5: PERIODIC TESTS

Meters properly selected according to size and type will provide satisfactory service over a long period of time without attention only if operated under ideal conditions. Under ordinary conditions, meters must be given some care if they are to function properly. In most cases, it is impossible to ascertain without an actual test whether a meter in service is registering with the required degree of accuracy. Consequently, to ensure reliable meter measurements, it is essential that all meters be subjected to periodic tests.

Sec. A.5.1 Time Intervals

The interval between tests and the method of conducting them must be governed largely by local conditions. Many state or provincial regulatory commissions specify intervals between tests on both a time and a quantity basis. Under average conditions, the intervals between tests should not exceed the limits set forth in Table A.1. The time interval between tests should be based on local conditions and the amount of consumption. Section A.4 should be reviewed in its entirety before the establishment of test intervals for individual utilities. The interval between tests may be increased by 50 percent for meters with magnetic couplings and self-lubricating gear materials.

SECTION A.6: METER STORAGE

Meters should be stored in locations that are not subject to unduly high or low temperatures. Meters to be stored outdoors for an extended period of time should be capped and covered to protect them from exposure to direct sunlight.

Table A.1 Most frequently used intervals between meter tests

Meter Size		
in.	*(mm)*	Years Between Tests
⅝	(15)	10
¾	(20)	8
1	(25)	6
1½	(40)	4
2	(50)	4

SECTION A.7: INSTALLATION

All instruction manuals supplied by the manufacturer should be reviewed in detail before installation of meters. Service line valves before and after the water meter are recommended to facilitate customer shutoffs and meter servicing or replacement. It is recommended that new service lines be flushed before installing the water meter. A spool piece of a length matching the meter to be installed should be used in place of the installed meter when flushing. An old meter with the measuring element removed could be substituted for the spool piece.

Sec. A.7.1 Electrical Grounded Pipe Systems

"AWWA opposes the systematic interchange of stray electric current between electrical distribution systems and water distribution systems, as well as the use of the water pipe system as an essential part of any electrical system. AWWA does not object, however, to the connection of all interior piping of a building to the electrical service neutral and to a separate grounding electrode, provided that such interior pipe systems and grounding connections are electrically isolated from the water utility pipe system."* At the time this edition of ANSI/AWWA C708 was published, the AWWA policy statement on the grounding of electrical circuits to water pipes had last been revised on Jan. 19, 2014. However, it must be recognized that many pipe systems continue to be used as a grounding electrode system.

Section 250.53(D) of the National Electrical Code® (NEC) requires that "continuity of the grounding path or bonding connection to interior piping shall not rely on water meters."† Most utilities require a permanent conductive meter setting or a conductive grounding strapping around meters to prevent accidents to service workers changing meters. All meters, both metal and plastic, should be installed in permanent metallic meter setters or provided with permanent ground-strapped strapping. This is especially important in the case of plastic main cases or plastic meter couplings, which are nonconductors of electricity.

Sec. A.7.2 Misaligned Pipes

The meter should be set in a horizontal position, protected from freezing, damage, and tampering. The line opening in which the meter is to be set should match the lay length of the meter, allowing slight additional space for coupling gaskets. The

* Statement of Policy on Public Water Supply Matters: Grounding of Electrical Circuits on Water Pipe, AWWA, Denver (2014).

† Available from the National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169.

service line configuration should have straight piping, which is necessary for proper flow conditioning both upstream and downstream from the meter. The meter should not be used to straighten misaligned pipes because of the potential for damage to the meter. This is especially true when meters with plastic threads are installed in outdoor pits. Installing meters with plastic threads in outdoor pit settings where the service lines are subjected to continual misalignment because of ground shifting should be avoided unless meter sets or other specialty connectors are used. Proper alignment of piping during installation and prior to the meter installation can be facilitated by the use of a spool piece of the proper length.

Sec. A.7.3 Meter Installation Methods

To prevent cross-threading at installation, set the meter between the coupling nuts with the direction of flow through the meter corresponding to the direction of flow in the system. Engage the coupling nuts to the threaded meter ends. Check to ensure the nuts are properly aligned to avoid cross-threading damage to the threaded meter ends.

An effective method for properly starting meter coupling nuts is to position the nut squarely against the meter spud end. Turn the nut counterclockwise (in reverse) while holding the nut against the meter spud end. When the first threads on both the coupling nut and the meter spud end coincide, a slight clicking or snap will be heard as the nut moves into the starting position. Turn the nut clockwise to complete the connection.

On plastic-thread systems, avoid using pipe wrenches on the meter body itself. After the coupling nut has engaged the first thread of the meter, tighten the coupling nut clockwise by hand until it is tight, and then apply a partial turn with an open-end wrench. Do not overtighten. Pipe dope and sealants are not required or recommended. Soft rubber gaskets, rather than fiber or leather washers, are recommended for plastic meter thread systems.

Sec. A.7.4 Placing Meter in Service

After the line has been thoroughly flushed, open the shutoff valve slowly to pressurize the service line to the meter setting. Slowly open the inlet side valve, which will fill the meter with water. Check for leaks around the meter and connections. Open the meter outlet side valve slowly to pressurize the consumer side of the system. Open a consumer faucet slowly to allow entrapped air to escape. Turn off the faucet.

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ISBN 978-1-62576-057-9

1P–2M 43708-2015 (02/15) IW

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