



**American Water Works
Association**

ANSI/AWWA C219-11
(Revision of ANSI/AWWA C219-06)

The Authoritative Resource on Safe Water®

AWWA Standard

Bolted, Sleeve-Type Couplings for Plain-End Pipe



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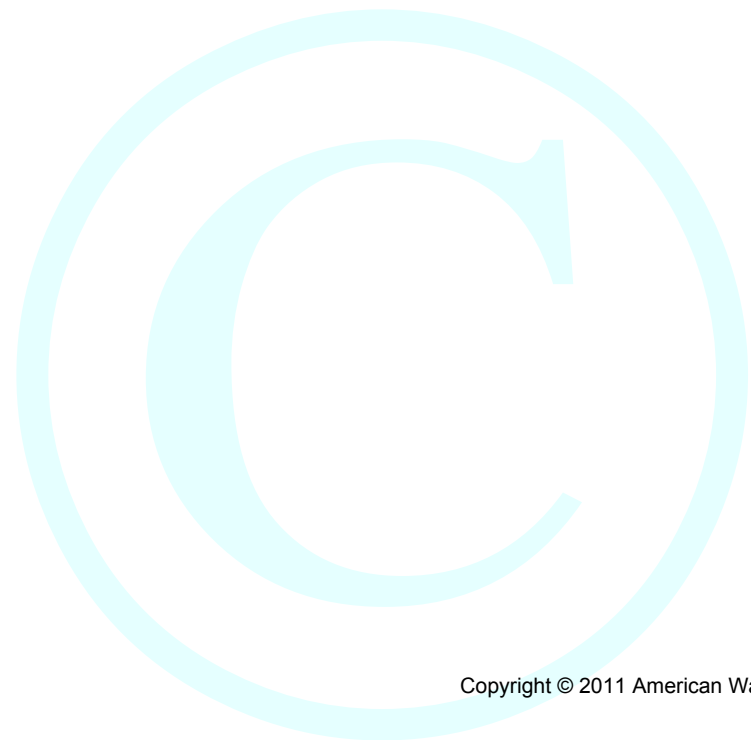
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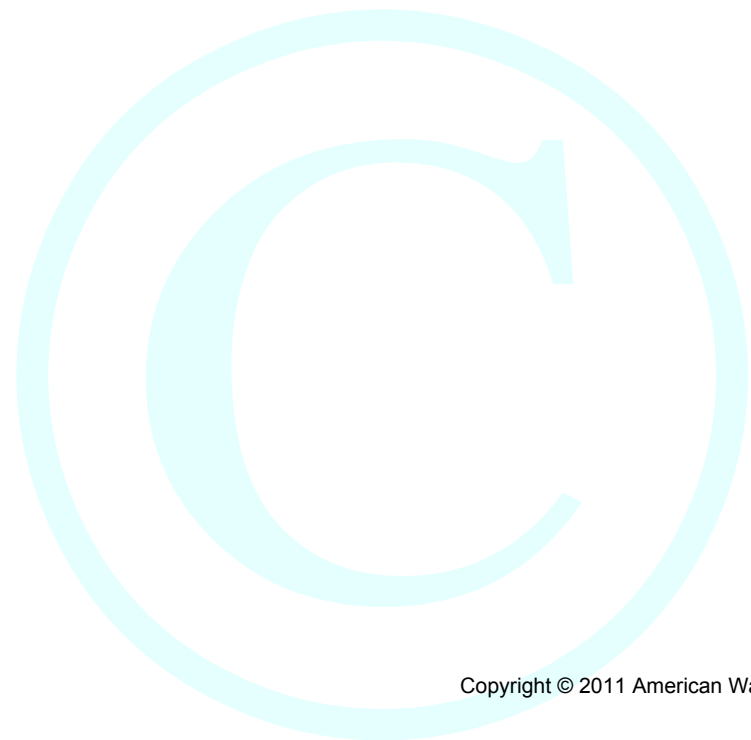


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Foreword

This foreword is for information only and is not a part of ANSI/AWWA C219.*

I. Introduction.

I.A. *Background.* This standard describes bolted, sleeve-type couplings, reducing or transition couplings, and flanged coupling adapters used to join plain-end pipe. It also includes materials of construction, inspection, and testing.

I.B. *History.* The first edition of ANSI/AWWA C219 was approved by the AWWA Board of Directors on June 23, 1991. Subsequent editions were approved on June 15, 1997, Jan. 21, 2001, and Feb. 12, 2006. This fifth edition was approved on Jan. 23, 2011.

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[†] and the Conference of State Health and Environmental Managers (COSHEM). The 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.

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

† Water Research Foundation, 6666 W. Quincy Avenue, Denver, CO 80235.

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

§ NSF International, 789 N. Dixboro Road, Ann Arbor, MI 48105.

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 jurisdiction. 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.

ANSI/AWWA C219 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. *Advisory Information on Product Application.* Bolted, sleeve-type couplings have been used for joining plain-end pipe since the latter part of the 19th century. Currently, there are several manufacturers who produce these couplings. Though details differ, couplings of this type work the same way and have similar components: a center sleeve (sometimes called a “middle ring”), end rings (sometimes called “followers”), and threaded fasteners (bolts and nuts) that, when tightened, pull the end rings together. These components compress elastomeric gaskets in the space formed between the end rings, center sleeve, and pipes being joined, thereby sealing the coupling-and-pipe combination.

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 items should be

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

provided by the purchaser.

1. Standard used—that is, ANSI/AWWA C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe, of latest revision.

2. Quantity.

3. Wall thickness, schedule, or class.

4. Flange specification for flanged coupling adapters.

5. Whether compliance with NSF/ANSI 61, Drinking Water System Components—Health Effects, is required.

6. Actual outside diameter(s) (OD) of pipe ends, including any coatings (Section 3[1]).

7. Nominal pipe size(s) (Section 3[12] and Table 4).

8. Rated pressure, including transient pressure, and the test pressure (Section 3[14] and 4.3.1).

9. Details of other federal, state or provincial, and local requirements (Sec. 4.2.1).

10. Operating temperature range (Sec. 4.2.3.1 and 4.2.3.2).

11. Type of service (Sec. 4.2.3.2 and 4.2.3.3).

12. Length and thickness of center sleeve where special performance or installation requirements exist (Sec. 4.3.2 and Table 2).

13. Anticipated angular deflection of pipes (Sec. 4.5 and Table 3).

14. Special requirements, such as coatings (Sec. 4.6.2), gasket material (Sec. 4.2.3 and 4.2.3.1), gaskets for electrical insulation (Sec. 4.2.3.3), and special type of bolting (Sec. 4.2.5).

15. Type of pipe(s), including specification to which it is made or specification and tolerance of pipe ends (Sec. 4.7.2 and Table 4).

16. Purchaser's pipe-end preparation requirements (Sec. 4.7.2).

17. Additional nondestructive weld evaluation (Sec. 5.1.1.1.1).

18. Material certifications (Sec. 5.1.1.3).

19. Purchaser's inspection requirements (Sec. 5.1.2).

20. Hydrostatic test data report (Sec. 5.2.2.2).

21. Purchaser's proof test requirements (Sec. 5.2.4).

22. Marking of rated pressure (Sec. 6.1, Item 4).

23. Affidavit of compliance, if required (Sec. 6.3).

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

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

1. A reference to AWS D1.6, Structural Welding Code for Stainless Steel, was

added under Section 2, References; Sec. 4.4.1.1, Steel center sleeves; and Sec. 4.4.2.1, Steel end rings.

2. Added Standards Council standard language in Sec. 4.1, Permeation, and Sec. 4.2.1, Material compliance.

3. A revision was made to Sec. 4.5, Performance, regarding angular pipe movement.

4. A note that coatings are not applicable for stainless-steel couplings was added in Sec. 4.6.1, Standard shop coatings.

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



**American Water Works
Association**

AWWA Standard

Bolted, Sleeve-Type Couplings for Plain-End Pipe

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes bolted, sleeve-type couplings, reducing or transition couplings, and flanged coupling adapters (couplings) used to join plain-end pipe. Couplings may be manufactured from carbon steel, stainless steel, ductile iron, or malleable iron and are intended for use in systems conveying water. This standard describes nominal coupling sizes from ½ in. (13 mm)* through 144 in. (3,600 mm).

Sec. 1.2 Purpose

The purpose of this standard is to provide the minimum requirements for couplings of plain-end pipe, including requirements for materials, design, testing and inspection, installation, and shipping.

Sec. 1.3 Application

This standard can be referenced in documents for purchasing the described couplings. The stipulations of this standard apply when this document has been referenced.

* Metric conversions given in this standard are direct conversions of US customary units and are not those specified in International Organization for Standardization (ISO) standards.

SECTION 2: REFERENCES

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

ANSI*/AWWA C200—Steel Water Pipe—6 In. (150 mm) and Larger.

ANSI/AWWA C210—Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

ANSI/AWWA C213—Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.

ANSI/AWWA C218—Liquid Coating Systems for the Exterior of Above-ground Steel Water Pipelines and Fittings.

ANSI/AWWA C222—Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings.

ANSI/AWWA C224—Nylon-11-Based Polyamide Coating System for the Interior and Exterior of Steel Water Pipe, Connections, Fittings, and Special Sections.

ANSI/AWWA C550—Protective Interior Coatings for Valves and Hydrants.

ASME[†] B1.1—Unified Inch Screw Threads, UN and UNR Thread Form.

ASME B1.13M (Metric)—Metric Screw Threads: M Profile.

ASME B18.2.1—Square and Hex Bolts and Screws Inch Series.

ASME B18.2.2—Square and Hex Nuts.

ASME B18.2.3.6M—Metric Heavy Hex Bolts.

ASME B18.2.4.6M—Metric Heavy Hex Nuts.

ASME—Boiler and Pressure Vessel Codes.

ASTM[‡] A47—Standard Specification for Ferritic Malleable Iron Castings.

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

ASTM A283/A283M—Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

ASTM A307—Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

ASTM A380—Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.

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

† ASME International, Three Park Avenue, New York, NY 10016.

‡ ASTM International, 100 Bar Harbor Drive, West Conshohocken, PA 19428.

ASTM A536—Standard Specification for Ductile Iron Castings.

ASTM A563/ASTM A563M—Standard Specification for Carbon and Alloy Steel Nuts.

ASTM A576—Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.

ASTM A666—Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

ASTM A967—Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.

ASTM D395—Standard Test Methods for Rubber Property-Compression Set.

ASTM D412—Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension.

ASTM D572—Standard Test Method for Rubber-Deterioration by Heat and Oxygen.

ASTM D1149—Standard Test Method for Rubber Deterioration-Surface Ozone Cracking in a Chamber.

ASTM D2000—Standard Classification System for Rubber Products in Automotive Applications.

ASTM D2240—Standard Test Method for Rubber Property-Durometer Hardness.

ASTM F568M—Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners.

ASTM F593—Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

ASTM F594—Standard Specification for Stainless Steel Nuts.

ASTM F738M—Standard Specification for Stainless Steel Metric Bolts, Screws, and Studs.

ASTM F836M—Standard Specification for Style 1 Stainless Steel Metric Nuts.

AWS* D1.1—Structural Welding Code—Steel.

AWS D1.6 – Structural Welding Code – Stainless Steel.

AWWA Manual M11: *Steel Pipe—A Guide for Design and Installation*. AWWA, Denver, Colo.

* American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

SECTION 3: DEFINITIONS

The following definitions shall apply in this standard (refer to Figures 1 and 2).

1. *Actual outside diameter:* The pipe outside diameter (including any coating).

2. *Angular deflection:* The angle between the longitudinal axes of the pipes joined by the coupling.

3. *Center sleeve (center ring, middle ring):* A cylinder of sufficient length to fully enclose both pipe ends.

4. *Constructor:* The party that provides the work and materials for placement or installation.

5. *Coupling:* An assembly consisting of a center sleeve, gaskets, and end rings connected with bolts and nuts or other type of threaded fasteners. Tightening the fasteners transfers the load through the end rings and compresses the gaskets into the space between the inside of the center sleeve and the outside surface of the pipe ends.

6. *Design pressure:* See rated pressure.

7. *End ring (follower ring):* A ring that provides a means of compressing the coupling gasket(s).

8. *Flanged-coupling adapter:* A coupling used to connect plain-end pipe to a flange. It consists of a flange, center sleeve, gasket, and an end ring connected with bolts and nuts or other threaded fasteners.

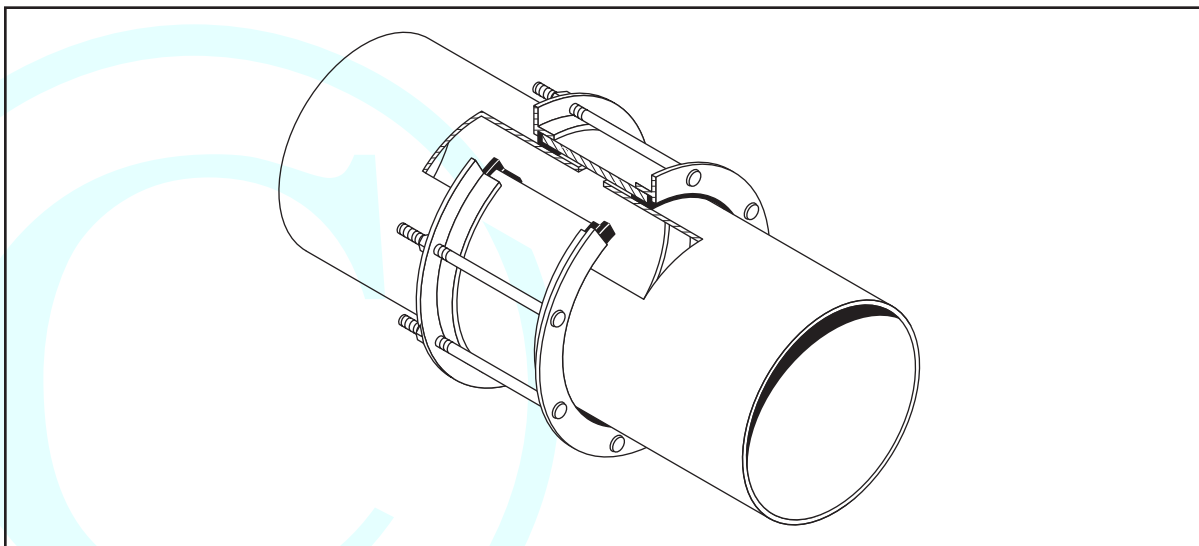


Figure 1 Typical straight coupling

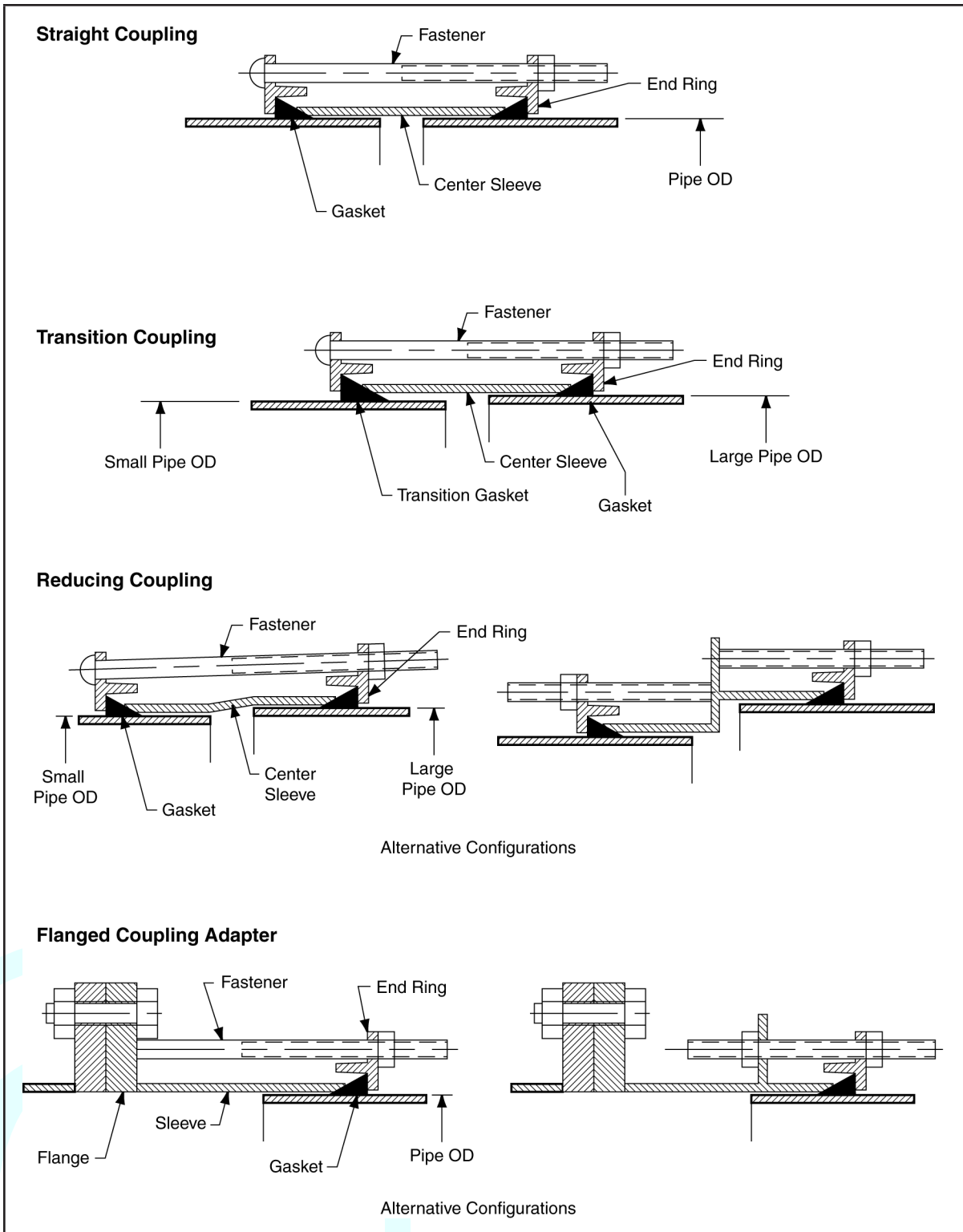


Figure 2 Typical coupling configurations

9. *Gasket*: An elastomeric ring that provides the pressure seal of the coupling.

10. *Insulating coupling*: A coupling used to break electrical continuity between two pipes. This is normally done by means of special insulating gaskets.

11. *Manufacturer*: The party that manufactures, fabricates, or produces the materials or products.

12. *Nominal pipe size*: The commercial designation or dimension by which the pipe is identified. The designation may not be the same as the actual outside diameter.

13. *Purchaser*: The person, company, or organization that purchases any materials or work to be performed.

14. *Rated pressure*: The maximum internal hydrostatic pressure to which the coupling is to be subjected under normal operating conditions. In addition, transient and test pressures should be considered in the design by the purchaser.

15. *Reducing coupling*: A coupling that uses end rings of different sizes and a center sleeve with ends of proper inside diameter to join pipes of different outside diameters. The center sleeve may be a single piece or several pieces sized to accommodate the different pipe diameters.

16. *Supplier*: The party that supplies materials or services. A supplier may or may not be the manufacturer.

17. *Test pressure*: Hydrostatic test pressure for proof of design.

18. *Transient pressure*: Surge or other pressures that exceed normal operating conditions and are of short duration.

19. *Transition coupling*: A coupling used to join pipe of the same nominal size, but of differing outside diameters. Differences in pipe outside diameters are accommodated by specially sized gaskets and, when necessary, specially sized end rings.

SECTION 4: REQUIREMENTS

Sec. 4.1 Permeation

The selection of materials is critical for potable water, wastewater, and reclaimed water service and distribution piping in locations where there is likelihood the pipe will be exposed to significant concentrations of pollutants composed of low-molecular-weight petroleum products or organic solvents or their vapors. Documented research has shown that pipe materials (such as polyethylene and

polyvinyl chloride) and elastomers, such as used in jointing gaskets and packing glands, are subject to permeation by low-molecular-weight organic solvents or petroleum products. If a potable water, wastewater, or reclaimed water pipe must pass through such a contaminated area or an area subject to contamination, consult with the manufacturer regarding permeation of pipe walls, jointing materials, and so forth, before selecting materials for use in that area.

Sec. 4.2 Materials of Construction

4.2.1 *Material compliance.* Materials shall comply with the requirements of the Safe Drinking Water Act and other federal regulations for potable water, wastewater systems, or reclaimed water as applicable.

4.2.2 *Center sleeves.* Center sleeves may be manufactured from carbon steel, stainless steel, ductile iron, or malleable iron, as described in the sections that follow. After forming, welding, or casting into a complete integral circle, the center sleeves must remain in a complete integral circle after manufacturing and testing processes have been completed.

4.2.2.1 *Steel center sleeves.* Steel center sleeves shall be formed from a material that meets or exceeds the requirements of ASTM A283/A283M, Grade C for carbon steel, or ASTM A666, type 304/304L for stainless steel. Other grades of steel with equivalent or higher specified yield strength, such as those listed in ANSI/AWWA C200 and AWWA Manual M11, may be used. Sleeves made from mill pipe or tubing shall satisfy the material requirements of ANSI/AWWA C200.

4.2.2.2 *Iron center sleeves.* Center sleeves manufactured from ductile iron shall meet the minimum requirements of ASTM A536, Grade 65-45-12. Center sleeves manufactured from malleable iron shall meet the minimum requirements of ASTM A47, Grade 32510 or 35018.

4.2.3 *Gaskets.*

4.2.3.1 *Composition and physical requirements.* Gaskets shall be vulcanized, molded or extruded, natural or synthetic rubber, and free from porous areas, foreign materials, and visible defects. Reclaimed rubber shall not be used. Unless otherwise specified by the purchaser, gaskets shall be suitable for water service to 150°F (66°C). Gaskets shall meet the requirements of ASTM D2000, and gasket material shall have the minimum physical properties shown in Table 1.

4.2.3.2 *Special service requirements.* Where service conditions differ from those described in Sec. 4.2.3.1, special gasket material may be required. The purchaser must specify service conditions.

4.2.3.3 *Special gaskets for electrical insulation.* An insulating boot may be used, extending over one pipe a minimum of 1 in. (25 mm) beyond the end

Table 1 Minimum physical properties of gasket material

Physical Property	Property Value	Test Procedure
Durometer hardness Shore "A," points	75, ±5	ASTM D2240
Tensile strength, minimum ultimate, psi (MPa)	1,300 (9.0)	ASTM D412
Ultimate elongation, minimum, percent	150	ASTM D412
Proportion of original tensile and elongation after aging, percent	60	ASTM D572 (oxygen pressure method): 96 hr at 122°F ±1.2°F (50°C ±0.5°C) and 300 psi ±10 psi (2,068 kPa ±69 kPa)
Maximum compression set, percent	20	ASTM D395, Method B
Resistance to surface ozone cracking	No cracking	ASTM D1149, after 25 hr minimum exposure in 50 pphm ozone concentration at 104°F (40°C) on a loop-mounted gasket with approximately 20% elongation at outer surface
Color	Black	
Surface	Nonblooming	

of the coupling, thereby preventing any metal-to-metal contact between the pipe ends. The purchaser must specify the need for insulation requirements.

4.2.4 *End rings.*

4.2.4.1 *Steel end rings.* Steel end rings shall be made from a material that meets or exceeds the requirements of ASTM A576, Grade 1020 for carbon steel, or ASTM A276, type 304/304L for stainless steel. Other grades of steel with equivalent or higher specified minimum yield strengths may be used, provided they conform to a nationally recognized standard.

4.2.4.2 *Iron end rings.* Ductile-iron end rings shall be manufactured from ductile iron conforming to ASTM A536, Grade 65-45-12. End rings manufactured from malleable iron shall conform to ASTM A47, Grade 32510 or 35018.

4.2.5 *Bolting.*

4.2.5.1 *Similar materials.* Similar materials shall be used for bolts, nuts, and washers (when used) to minimize the possibility of galvanic corrosion. Caution should be used in buried installations or where the environment is highly corrosive to ensure that the bolts and nuts are properly protected. Advice from a qualified corrosion engineer is recommended. Manufacturers shall provide bolts, nuts, and washers (when required) of suitable quality, workmanship, and yield strength to ensure compatibility with the coupling design and rated working pressure. The purchaser may

request the manufacturer's certification of bolting material, complete with physical, chemical, and dimensional details.

4.2.5.1.1 Steel bolts shall meet or exceed the requirements of ASTM A307 or ASTM F568M for carbon steel, or ASTM F593 or ASTM F738M for stainless steel. Nuts shall meet or exceed the requirements of ASTM A563 or ASTM A563M for carbon steel, or ASTM F594 or ASTM F836M for stainless steel. Other grades of bolts and nuts with equivalent or higher specified minimum yield strengths may be used, as agreed to by the purchaser. Stainless-steel bolt and nut threads may gall, which may cause erroneous torque readings during installation, leading to improper gasket compression and leakage. Contact the manufacturer for recommendations.

4.2.5.1.2 Iron bolts and nuts shall meet or exceed the requirements of ASTM A536, Grade 65-45-12.

Sec. 4.3 Design of Bolted Couplings

4.3.1 *General.* To retain sealing performance, couplings shall be designed to control long-term relaxation of gaskets caused by the creep properties of elastomeric compounds. The purchaser must provide the rated pressure, transient pressure, and the test pressure to which the coupling will be subjected during service.

4.3.2 *Center sleeves.* Unless otherwise specified by the purchaser, the manufacturer will determine the proper thickness of the sleeve material and sleeve length for the use prescribed by the purchaser. Center sleeves must meet the minimum lengths shown in Table 2. The Barlow formula shall be used to determine the minimum center sleeve thickness.

$$t = \frac{PD}{2S} \quad (\text{Eq 1})$$

or

$$t = \frac{(P + P_t)D}{2S_t} \quad (\text{Eq 2})$$

whichever is greater.

Where:

t = thickness of center sleeve, in. (mm)

P = rated pressure of coupling, psi (MPa)

P_t = transient pressure of coupling, psi (MPa)

D = outside diameter of center sleeve, in. (mm)

S = $0.5 \times$ specified minimum yield strength of center-sleeve material, psi (MPa)

S_t = $0.75 \times$ specified minimum yield strength of center-sleeve material, psi (MPa)

Table 2 Minimum center-sleeve length

Nominal Pipe Size Group		Minimum Center-Sleeve Length	
<i>in.</i>	<i>(mm)</i>	<i>in.</i>	<i>(mm)</i>
1/2 to ≤ 2	(13 to ≤ 50)	3 1/2	(89)
> 2 to ≤ 12	(> 50 to ≤ 300)	4	(102)
> 12 to ≤ 18	(> 300 to ≤ 450)	5	(127)
> 18 to ≤ 36	(> 450 to ≤ 900)	6	(152)
> 36 to ≤ 72	(> 900 to ≤ 1,800)	7	(178)
> 72	(> 1,800)	10	(254)

4.3.3 *End rings.* End rings shall be of sufficient cross section and strength to obtain a leakproof test at 1.5 times the maximum rated pressure. After final bolt tightening to the coupling manufacturer's recommended torques, the end rings shall not roll more than 3.5° from their original position prior to bolting.

4.3.4 *Bolting.* The size, type, and number of bolts shall be such that when they are tightened during installation procedures to the recommended torque, the resulting gasket compression will provide a watertight seal at 1.5 times the rated pressure of the coupling. The manufacturer's recommended torque shall not result in the bolts being tightened beyond the yield point of the bolt material.

4.3.4.1 Bolts may be headed or nonheaded rod threaded on both ends. Bolt heads may include track-head, hexagonal-head, carriage-head, T-head, or D-head types. Hexagonal-head bolts shall be heavy hexagonal in accordance with ASME B18.2.1 or ASME B18.2.3.6M. All-thread rod is not acceptable.

4.3.4.2 Nuts. Nuts shall be heavy hexagonal in accordance with ASME B18.2.2 or ASME B18.2.4.6M.

4.3.4.3 Threads. Nuts and bolts shall be threaded in accordance with ASME B1.1. Coarse-thread series or coarse-pitch metric threads as defined in ASME B1.13M.

Sec. 4.4 Detailed Design and Manufacture

4.4.1 *Center sleeves.* Center sleeves shall be round and free of irregularities, flat spots, or surface defects that would impair the performance of the coupling.

4.4.1.1 Steel center sleeves. Sleeves shall be made from pipe, tubing, plate, or mill-rolled sections, with ends beveled to provide a suitable gasket seating surface.

Each roll-formed sleeve shall be welded with complete joint penetration welded butt joints after rolling. The welding process may use fusion or flash welding. After welding, each roll-formed and welded sleeve shall be cold-expanded at a stress beyond the yield point of the steel used, to result in a permanent expansion sufficient to ensure circularity of the sleeve and strength of the weld (normally a minimum of 1 percent of the diameter). See Sec. 5.1.1.1 for weld acceptance criteria. Where cold expansion is not used, each center sleeve shall be hydrostatically tested prior to shipment in accordance with Section 5. In lieu of hydrotesting, at the purchaser's option, welds may be examined by radiography or ultrasonics, in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, AWS D1.1, or AWS D1.6, or by any other nondestructive test method mutually agreed to by the purchaser and manufacturer. Sleeves manufactured from previously pressure-tested pipe or tubing need not be expanded or hydrostatically tested.

4.4.1.2 *Iron center sleeves.* Gasket-bearing areas shall be in the form of a smooth taper, cast into the sleeve, and free from defects that may impair the function of the coupling.

4.4.2 *End rings.* End-ring assemblies shall be designed to provide uniform support under bolt heads and nuts.

4.4.2.1 *Steel end rings.* End rings may be stamped from flat stock. End rings formed from a fabricated or hot-rolled special steel section and fusion or flash-welded at the seam shall be cold-expanded beyond the yield point of the steel used. Where cold expansion is impractical, welds shall be examined by radiography or ultrasonics, in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, AWS D1.1, or AWS D1.6, or by any other nondestructive test method mutually agreed to by the purchaser and manufacturer. Bolt holes may be punched, thermal cut, drilled, or cut using a water jet.

4.4.2.2 *Cast end rings.* Bolt holes shall be cast or drilled in end rings. The finished castings shall be free of irregularities, flat spots, and surface defects that would impair the function of the coupling.

4.4.3 *Gaskets.*

4.4.3.1 *Configuration.* Gaskets shall be of such size and shape as to conform to the sealing surfaces of the coupling and effect a positive seal on the pipe surface.

4.4.3.2 *Marking.* The gasket shall be indelibly marked with the manufacturer's identification, pipe outside diameter, material, and year of manufacture.

4.4.3.3 Special service gaskets. For insulating gaskets or gaskets for special service conditions, the manufacturer must be consulted.

Sec. 4.5 Performance

When correctly installed according to the manufacturer's installation instructions and properly supported, couplings sized 10 in. (250 mm) and larger shall accommodate longitudinal pipe movement of $\frac{3}{8}$ in. (9.5 mm) per joint without leakage. For angular pipe movement while in service, consult the manufacturer. For sizes smaller than 10 in. (250 mm), the manufacturer shall be consulted for recommended limits on pipe movement. Couplings do not resist end load; therefore, pipelines must be provided with suitable anchorage, thrust blocks, or harness assemblies to prevent accumulation of pipe movement, which could result in pipe pull-out from the coupling (refer to AWWA Manual M11).

Without special design considerations, couplings will only transmit minor shear forces. Differential settlement conditions may require the use of multiple couplings. The coupling shall allow, within the center sleeve, angular deflection of the pipe axis to varying amounts, dependent on diameter, center-sleeve length, and pipe-end gap (see Table 3). This angular deflection shall occur without leakage and without distortion of any metallic components of the coupling at hydrostatic test pressure. When a specific amount of angular deflection to the pipe axis is required, the purchaser must specify the required deflection. If the anticipated deflection exceeds the value shown in Table 3, the manufacturer shall supply supporting calculations upon request.

Flanged coupling adapters provide half the expansion, contraction, and deflection of the full coupling.

The maximum allowable angular deflections shown in Table 3 should only be used when the pipes will not move in service.

Sec. 4.6 Coatings

4.6.1 *Standard shop coatings.* Unless otherwise specified by the purchaser, couplings shall receive an interior and exterior coating to inhibit rust during transit. Coatings are not applicable for stainless-steel couplings.

4.6.2 *Optional coatings.* The purchaser may specify certain other optional interior and exterior coatings conforming to ANSI/AWWA C210, ANSI/AWWA C213, ANSI/AWWA C218, ANSI/AWWA C222, ANSI/AWWA C224, ANSI/AWWA C550, or other coatings agreed to by the manufacturer. The desired interior and exterior coating should be specified by the purchaser. The thickness of optional lining and coating systems may be limited by the working tolerances of

Table 3 Maximum angular deflection (no in-service movement)

Nominal Pipe Group Size		Center-Sleeve Length, in. (mm)					
		3.5	4.0	5.0	6.0	7.0	10.0
<i>in.</i>	<i>(mm)</i>	(89)	(102)	(127)	(152)	(178)	(254)
		Values in Degrees					
½ to ≤ 2	(>13 to ≤ 50)	4	4	4	4	4	4
>2 to ≤ 12	(>50 to ≤ 300)	*	4	4	4	4	4
>12 to ≤ 18	(>300 to ≤ 450)		*	2.5	3	4	4
>18 to ≤ 24	(>450 to ≤ 600)			*	3	4	4
>24 to ≤ 36	(>600 to ≤ 900)				2	3	3
>36 to ≤ 48	(>900 to ≤ 1,200)				*	2	2.5
>48 to ≤ 72	(>1,200 to ≤ 1,800)					1.5	2
>72 to ≤ 120	(>1,800 to ≤ 3,000)					*	1
>120 [†]	(> 3,000)						*

NOTE: For each pipe size/sleeve length combination, Table 3 indicates the angular deflection between connected pipes that can be provided by a coupling complying with the requirements of this standard. Individual manufacturer's designs may allow greater angular deflection than those indicated in this table.

*Pipe size/sleeve length combinations not listed in this table should not be used except by special agreement between the manufacturer and purchaser.

†Contact individual manufacturers for sizes larger than 120 in. (3,000 mm).

the coupling components. The purchaser should consult with coupling manufacturers to establish these limitations.

4.6.3 Passivation of stainless steel. All stainless-steel surfaces and weldments shall be passivated, in accordance with ASTM A380 or ASTM A967.

Sec. 4.7 Installation

4.7.1 General. A bolted, sleeve-type coupling for plain-end pipe is one component of a piping system. The coupling's performance depends on being sized correctly and installed properly on pipe having suitable end conditions.

4.7.2 Pipe-end preparation and surface requirements. When couplings are to be used to join pipe, the purchaser should specify that the pipe shall be specially prepared within a distance from each pipe end equal to or greater than the length of the center sleeve of the coupling (see Table 2). The special preparations include

1. Couplings are manufactured based on the outside diameter of plain-end pipe with tolerances not exceeding those listed in Table 4.

Table 4 Pipe-end diameter tolerances

Nominal Pipe Size		Tolerances on Actual Outside Diameter (OD)	
<i>in.</i>	<i>(mm)</i>	<i>in.</i>	<i>(mm)</i>
½ to ≤ 16	(13 to ≤ 400)	± 0.06	(± 1.5)
> 16 to ≤ 24	(> 400 to ≤ 600)	± 0.08	(± 2.0)
> 24 to ≤ 42	(> 600 to ≤ 1,050)	± 0.10	(± 2.5)
> 42	(> 1,050)	+0.12/−0.06	(+3/−1.5)

2. The exterior pipe surface within the area delineated above shall be round, smooth, and free from weld reinforcement (bead), seams, scars, dents, flats, or other defects likely to interfere with the joint-sealing process.

4.7.3 *Suitability of system components.* The recommendations stated in Sec. 4.4, Table 2, Table 4, and Sec. 4.7.3 will provide minimum acceptable performance according to this standard.

These recommendations may be varied with the pipe or coupling manufacturer by agreement with the purchaser to accommodate the following:

1. Specific performance characteristics of the coupling.
2. Particular operation requirements.
3. Installations requiring that the coupling be assembled by sliding it fully onto one pipe before bringing the other pipe into line. In such cases, the end conditions described in this section shall apply to the area within 1.5 times the center sleeve length.
4. Pipe ends not complying with tolerances stated in Table 4.

4.7.4 *Installation of couplings.*

4.7.4.1 *General.* Proper installation of couplings requires that the center sleeves be centered over the gap between the ends of the pipes being joined; the gap must conform to Table 5. When a water pipeline is under internal pressure, unbalanced forces develop at points where there are changes of size or direction of the pipeline. These unbalanced forces may result in pipe movement. Couplings do not provide protection against possible pull-out of pipe ends in unrestrained conditions. Suitable anchorage or harness assemblies shall be provided where excessive pipe or coupling movement may occur. Refer to AWWA Manual M11. Special attention must be given to the unbalanced thrust forces in transition and reducing couplings where the pressure tends to push the coupling toward the smaller pipe.

Table 5 Recommended centerline gaps

Center-Sleeve Length		Recommended Centerline Gaps				Maximum Permissible In-Service Centerline Gap‡	
		Straight-Run Pipe*		Deflected Joints†			
<i>in.</i>	<i>(mm)</i>	<i>in.</i>	<i>(mm)</i>	<i>in.</i>	<i>(mm)</i>	<i>in.</i>	<i>(mm)</i>
3.5	(89)	0.5	(13)	0.75	(19)	1.5	(38)
4	(102)	0.5	(13)	0.75	(19)	1.5	(38)
5	(127)	0.5	(13)	1	(25)	2	(51)
6	(152)	0.5	(13)	1	(25)	2	(51)
7	(178)	1	(25)	1.5	(38)	3	(76)
10	(254)	1	(25)	2.25	(57)	4.5	(114)

*Recommended centerline setting gaps for pipework that is not expected or able to deflect in service to an angularity greater than 25 percent of the relevant value stated in Table 3.

†It is recommended that initial pipe separation be based on the recommended centerline setting gap value. These values normally permit the full amount of angularity to take place without the pipe ends touching. These values may be varied according to installation conditions (such as required angularity, pipe-cutting tolerances, and so forth).

‡Maximum permissible centerline gap shall not be exceeded. Refer to AWWA Manual M11 for restraint requirements.

For gaskets to seal most effectively, contact surfaces shall be thoroughly cleaned just prior to assembly for a distance equal to center-sleeve length plus 2 in. (50 mm) on each pipe end to remove loose rust and foreign material.

4.7.4.2 Procedure. When pipe ends are properly prepared, installation shall be in accordance with the manufacturer's installation instructions.

SECTION 5: VERIFICATION

Sec. 5.1 Inspection

5.1.1 *Inspection by the manufacturer.* The manufacturer shall establish quality control and inspection measures necessary to ensure compliance with this standard.

5.1.1.1 Welds. After cold expansion, the weld areas of center sleeves and end rings shall be visually inspected for cracks or other defects in accordance with AWS D1.1, Section 6, or AWS D1.6, Section 6, visual inspection acceptance criteria for statically loaded nontubular connections.

5.1.1.1.1 Optional nondestructive examination. The purchaser may require the manufacturer to perform additional nondestructive examination of the welds.

5.1.1.2 Dimensions. A taping or gauging procedure shall be used to determine the inside diameter measurement of center sleeves and end rings to ensure a proper fit between the coupling assembly and the pipe it is designed to connect. Unless otherwise specified by the purchaser, the inside diameter of center sleeves shall be sized based on the pipe-end diameter tolerances stated in Table 4.

5.1.1.3 Materials. Material certifications shall be made available to the purchaser on request. The extent of such certifications shall be indicated by the purchaser at the time of request. Materials shall comply with the requirements of Sec. 4.2, except as modified by the purchaser. Materials that do not comply may be rejected by the purchaser.

5.1.2 *Inspection by the purchaser.* If the purchaser desires to inspect the couplings at the manufacturer's location, the purchaser shall so specify. The purchaser shall have free access to those parts of the manufacturer's facility that are necessary to ensure compliance with this standard. The manufacturer shall make available to the purchaser the equipment necessary for inspection. The manufacturer shall provide the purchaser with assistance, if necessary, in handling the items to be inspected.

Sec. 5.2 Tests

5.2.1 *Test pressures.* Hydrostatic test pressure, when required, shall be calculated by multiplying rated pressure by 1.5.

5.2.2 *Manufacturer's proof-of-design test.*

5.2.2.1 Tests required. For proof of design of each nominal pipe group stated in Table 2, it shall only be necessary to hydrostatically test a complete coupling assembly of the largest diameter and highest pressure rating contained in each nominal pipe group, provided the designs of the components within the group are essentially the same. To pass this test, the coupling must provide a leakproof seal at the test pressure, and the end rings must meet the criteria of Sec. 4.3.3.

5.2.2.2 Report. The manufacturer, when requested by the purchaser, shall provide test data to verify that the appropriate hydrostatic testing has been performed.

5.2.2.3 Test waiver. In lieu of the tests, manufacturers with at least five years' experience manufacturing bolted couplings shall provide documentation

acceptable to the purchaser that indicates the manufacturer has designed, manufactured, and provided couplings for water service at a rated pressure of at least 150 psi (1,034 kPa) for the largest diameter for the applicable group in Table 2.

5.2.3 *Production hydrostatic test.*

5.2.3.1 Steel center sleeves, cold expansion as a test. In most cases, cold expansion is part of the normal process for manufacturing steel center sleeves and end rings (Sec. 4.4.1.1 and 4.4.2.1). This process rounds and sizes the components and tests the parent metal and the butt-welded seam. When performed during manufacture, it is also considered an integral part of the testing and inspection procedure and eliminates the need for hydrostatic testing. Sleeves manufactured from previously pressure-tested pipe or tubing need not be expanded or hydrostatically tested. See Sec. 4.4.1.1 for test requirements for steel center sleeves produced without cold expansion of the components.

5.2.3.2 Iron couplings. The manufacturer shall qualify the design of the product by testing in accordance with Sec. 5.2.1 and 5.2.2. The manufacturer shall maintain records of this testing for the largest diameter and highest pressure-rated coupling in each nominal pipe size group (Table 2) as stated in Sec. 5.2.2.2.

5.2.4 *Purchaser's proof test.* The purchaser may specify individual hydrostatic proof testing. If individual hydrostatic proof testing is required, assembled couplings shall be tested at a maximum of 1.5 times the rated pressure. To pass this test, the coupling must provide a leakproof seal at the test pressure, and the end rings must meet the criteria of Sec. 4.3.3.

Sec. 5.3 Nonconformance

Couplings that fail to meet the provisions of this standard may be repaired and retested.

SECTION 6: DELIVERY

Sec. 6.1 Marking

At the time of shipment from the manufacturer, couplings shall be clearly marked with the following information:

1. Manufacturer's model number or type.
2. Pipe size (outside diameter of pipe).
3. Center-sleeve section identification, or, for steel center sleeves, thickness and length.

4. Rated pressure, when requested by the purchaser.

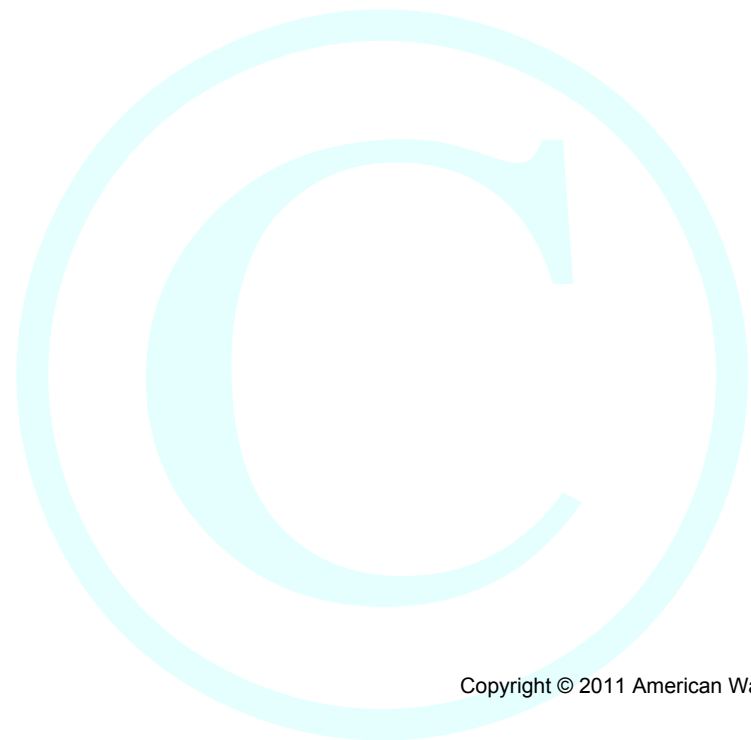
Sec. 6.2 Packaging and Shipping

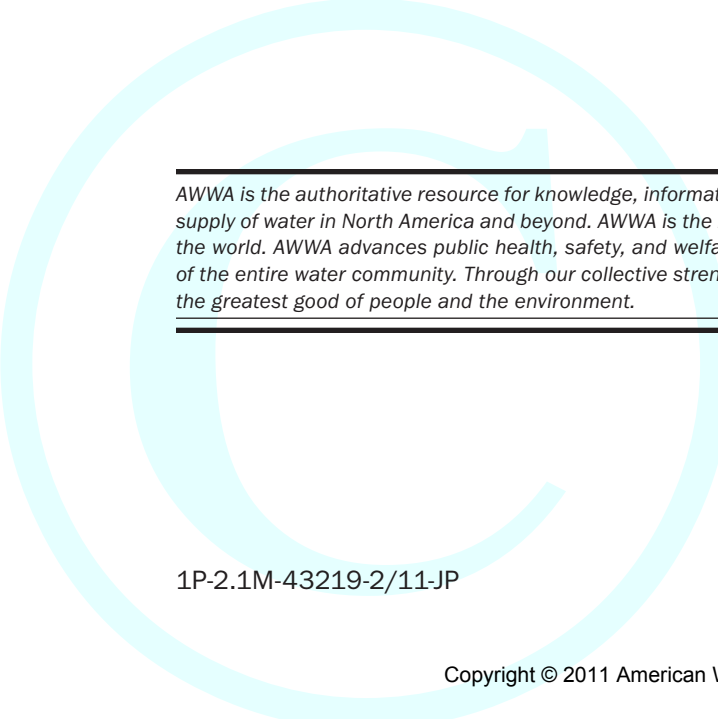
Care shall be taken to properly protect coupling components from distortion or other damage in shipment. If couplings are not shipped assembled, bolts, nuts and gaskets shall be packaged separately in containers suitable to withstand handling and storage.

Sec. 6.3 Affidavit of Compliance

The purchaser may require an affidavit from the manufacturer or supplier that the material provided complies with applicable requirements of this standard.

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