ASME B16.40-2019
(Revision of ASME B16.40-2013)

Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems

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Two Park Avenue • New York, NY • 10016 USA

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FOREWORD

The B16 Standards Committee was organized in the spring of 1920 and held its organizational meeting on November 21 of that year. The group operated as a Sectional Committee (later redesignated as a Standards Committee) under the authorization of the American Engineering Standards Committee [subsequently named American Standards Association, United States of America Standards Institute, and now American National Standards Institute (ANSI)]. Sponsors for the group were the American Society of Mechanical Engineers (ASME), Manufacturers Standardization Society of the Valve and Fittings Industry, and the Heating and Piping Contractors National Association (later the Mechanical Contractors Association of America).

The American Gas Association (A.G.A.) determined that standardization of gas valves used in distribution systems was desirable and needed. The A.G.A. Task Committee on Standards for Valves and Shutoffs was formed, and development work commenced in 1958. In 1968, it was determined that a more acceptable document would result if approval were gained from ANSI, and to facilitate such action, the A.G.A. Committee became Subcommittee No. 13 of the B16 activity. This B16 group was later renamed Subcommittee L, which is its current designation.

The first standard developed by Subcommittee L was ANSI B16.33. The ANSI B16.38 standard was subsequently developed to cover larger sizes of gas valves and shutoffs.

Since about 1965, the increased use of plastic piping in gas distribution systems brought with it the need for valves and shutoffs of compatible material. To fill this need, the present standard was developed and initially appeared as ANSI B16.40-1977. Subcommittee L began review of this document in 1982.

In ANSI/ASME B16.40-1985, editorial changes were made throughout the text to bring the format in line with the rest of the B16 series of standards and to clarify the intent of this Standard. Revisions included the addition of rules for allowable pressure at temperatures above 74°F for valves of certain materials, updating of reference standards, and editorial changes to text and tables.

In 2001, after several years and iterations, B16 Subcommittee L produced a fully revised document. Among the many revisions were a new Definitions section, a new Impact Resistance section, and a nonmandatory Quality Systems Program Annex.

Following approval by the B16 Standards Committee and the ASME Supervisory Board, an updated edition of this Standard was approved as an American National Standard by ANSI on March 18, 2008, with the designation ASME B16.40-2008. Five years later, the B16 Subcommittee L updated certain material specifications and included other editorial revisions to the text. That version of the Standard was approved as an American National Standard by ANSI on August 6, 2013 as ASME B16.40-2013.

In 2018, B16 Subcommittee L updated document and material references and made several editorial revisions to the text. This version of the Standard was approved as an American National Standard by ANSI on January 15, 2019 as ASME B16.40-2019.

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Standardization of Valves, Flanges, Fittings, and Gaskets

(The following is the roster of the Committee at the time of approval of this Standard.)

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General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions or a case, and attending Committee meetings. Correspondence should be addressed to:

Secretary, B16 Standards Committee
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Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Proposing a Case. Cases may be issued to provide alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee web page.

Requests for Cases shall provide a Statement of Need and Background Information. The request should identify the Standard and the paragraph, figure, or table number(s), and be written as a Question and Reply in the same format as existing Cases. Requests for Cases should also indicate the applicable edition(s) of the Standard to which the proposed Case applies.

Interpretations. Upon request, the B16 Standards Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the B16 Standards Committee.

Requests for interpretation should preferably be submitted through the online Interpretation Submittal Form. The form is accessible at http://go.asme.org/InterpretationRequest. Upon submittal of the form, the Inquirer will receive an automatic e-mail confirming receipt.

If the Inquirer is unable to use the online form, he/she may e-mail the request to the Secretary of the B16 Standards Committee at SecretaryB16@asme.org, or mail it to the above address. The request for an interpretation should be clear and unambiguous. It is further recommended that the Inquirer submit his/her request in the following format:

Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry in one or two words.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. Please provide a condensed and precise question, composed in such a way that a "yes" or "no" reply is acceptable.
Proposed Reply(ies):	Provide a proposed reply(ies) in the form of "Yes" or "No," with explanation as needed. If entering replies to more than one question, please number the questions and replies.
Background Information:	Provide the Committee with any background information that will assist the Committee in understanding the inquiry. The Inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

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Requests that are not in the format described above may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

Moreover, ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Standard requirements. If, based on the inquiry information submitted, it is the opinion of the Committee that the Inquirer should seek assistance, the inquiry will be returned with the recommendation that such assistance be obtained.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

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ASME B16.40-2019
SUMMARY OF CHANGES

Following approval by the ASME B16 Committee and ASME, and after public review, ASME B16.40-2019 was approved by the American National Standards Institute on January 15, 2019.

ASME B16.40-2019 includes the following changes identified by a margin note, **(19)**.

Page	*Location*	*Change (Record Number)*
1	1.2, 1.3, 1.4	Editorially revised for consistency with other B16 standards
1	1.5	Definition of DRv revised *(13-648)*
2	2.2.1	Revised *(19-350)*
2	3.2	Revised in its entirety *(19-350)*
2	4.2	Editorially revised
2	5	Subparagraphs (d) and (f) revised *(19-350)*
3	6.3.3	(1) Second paragraph revised *(19-350)*
		(2) Last sentence of subpara. (b) editorially revised to reflect parameters of table
5	Table 6.3.3-1	General Notes (a) through (d) revised as Referenced Notes (1) through (4); General Notes (e) and (f) revised to (a) and (b)
8	Mandatory Appendix II	(1) ASTM F2945 added *(19-350)*
		(2) Updated *(19-350)*

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LIST OF CHANGES IN RECORD NUMBER ORDER

Record Number	Change
13-648	Revised the definition of DRv to state which standards shall be used for PE and PA-11.
19-350	Changed “ASTM D2513” to “ASTM D2513 or ASTM F2945” in 2.2.1 and 5*(d)*. Revised 3.2 by deleting “or PA-11” and “F1733,” and adding new requirement (b). Relettered former (b) and (c). Added new sentence in 5(f) to include a substitute for date markings. Changed “may choose to” to “shall” in 6.3.3 and added a new sentence to allow an alternate pressure for the sustained-pressure test in small pipes which are designed with thicker walls for joining purposes and tolerance of process. Updated references in Mandatory Appendix II.

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MANUALLY OPERATED THERMOPLASTIC GAS SHUTOFFS AND VALVES IN GAS DISTRIBUTION SYSTEMS

1 SCOPE

1.1 General

(a) This Standard covers manually operated thermoplastic valves in nominal valve sizes $\frac{1}{2}$ through 12. These valves are intended for use below ground in thermoplastic fuel gas distribution mains and service lines. The maximum operating pressure (MOP) at which such distribution piping systems may be operated is in accordance with Transportation of Natural and Other Gas by Pipeline; Minimum Safety Standards [49 C.F.R., §192 (2017)] for temperature ranges of −20°F to 140°F (−29°C to 60°C).

(b) This Standard sets qualification requirements for each basic valve design as a necessary condition for demonstrating conformance to this Standard.

(c) This Standard sets requirements for newly manufactured valves for use in below-ground piping systems for fuel gas [includes synthetic natural gas (SNG)] and liquefied petroleum (LP) gases (distributed as a vapor, with or without the admixture of air) or mixtures thereof.

(19) 1.2 References

Standards and specifications adopted by reference are shown in Mandatory Appendix II, which is part of this Standard. It is not considered practical to identify the specific edition of each standard and specification in the text. Instead, the specific edition referenced is identified in Mandatory Appendix II.

(19) 1.3 Convention

For determining conformance with this Standard, the convention for fixing significant digits where limits (maximum and minimum values) are specified shall be as defined in ASTM E29. This requires that an observed or calculated value be rounded off to the nearest unit in the last right-hand digit used for expressing the limit. Decimal values and tolerances do not imply a particular method of measurement.

(19) 1.4 Relevant Units

This Standard states values in both U.S. Customary and SI (metric) units. These systems of units are to be regarded separately as standard. Within the text, the SI units are shown in parentheses. The values stated in each system are not exact equivalents; therefore, it is required that each system of units be used independently of the other. Combining values from the two systems constitutes nonconformance with the Standard.

1.5 Definitions (19)

basic valve design: each variation in material, size, or configuration of molded pressure-containing parts that constitutes a given valve design, except where minor design variations are produced by differences in machining of the same molded piece(s) to produce different end sizes or dimensional ratios (DRs).

DR: the dimensional ratio defined as the pipe outside diameter (O.D.) divided by the pipe wall thickness, t. DR = O.D./t.

DRv: the valve DR equivalent is the designated valve DR based on the lowest DR of the pipe ends used in long-term hydrostatic testing under this Standard. ASTM D2513 shall be the standard used for polyethylene (PE) and ASTM F2945 shall be the standard for polyamide 11 (PA-11).

fasteners: nuts, bolts, washers, clip rings, and other devices used in the assembly of valves.

lubricated valves: valves that require pressure lubrication (by the insertion through fittings of lubricant to the sealing surfaces of the valve) to effect a leak-tight seal.

NVS: nominal valve size.

pressure: unless otherwise stated, gage pressure.

production pressure tests: tests that include seat and closure-member and shell tests.

seat and closure-member test: an internal pressure test of closure-sealing elements (seats, seals, and closure members, e.g., gate, disc, ball, or plug).

shell test: an internal pressure test of the pressure-containing envelope.

valve design pressure: the pressure calculated by the method described in Mandatory Appendix I using the valve shell material's hydrostatic design basis (HDB) at 73°F (23°C).

1.6 Quality Systems

Nonmandatory requirements relating to the product manufacturer's Quality System Program are described in Nonmandatory Appendix A.

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2 CONSTRUCTION

2.1 General

(a) The workmanship used in the manufacture and assembly of each valve shall provide gas tightness, safety and reliability of performance, and freedom from injurious imperfections and defects.

(b) Design details not addressed in this Standard are the responsibility of the manufacturer.

2.2 Materials

(19) **2.2.1 Valve Shell.** The pressure-containing valve shell shall be made from either PE or PA-11 materials specified in and qualified to the requirements for pipe and fittings as listed in ASTM D2513 or ASTM F2945.

2.2.2 Parts Other Than the Valve Shell. Parts other than the valve shell that contribute to pressure containment or retaining differential pressure across the closure element shall be resistant to the gases in para. 1.1(c). Such parts shall be designed to withstand normal valve-operating loads and, in addition, shall provide long-term pressure-containment integrity consistent with the valve shell. The sustained pressure tests of para. 6.3.3 shall qualify the design and material selected for these parts, which include, but are not limited to, the closure member, stems or shafts (if they are designed to retain pressure), and fasteners retaining shell sections.

2.2.3 Lubricants and Sealants. Lubricants and sealants shall be resistant to the action of gases referred to in para. 1.1(c). Lubricated valves, as defined in para. 1.5, are not within the scope of this Standard.

2.2.4 Responsibility. When service conditions, such as gases having high hydrogen content or compounds likely to form condensate, dictate special materials considerations, it is the user's responsibility to specify this information to the manufacturer.

3 CONFIGURATION

3.1 Operating Indication

(a) Valves designed for one-quarter turn operation shall be designed to visually show the open and closed position of the valve. A rectangular stem head with an arrow thereon or a separate position indicator shall indicate the closed position of the valve port when the longitudinal axis of the stem head or indicator is perpendicular to the axis of the connecting pipe. If a separate indicator is used, it shall be designed such that it cannot be assembled to incorrectly indicate the position of the valve.

(b) Valves designed for more than one-quarter turn operation shall close by clockwise stem rotation, unless otherwise specified by the user. The direction for closing the valve shall be indicated.

3.2 Valve End Design (19)

Valve ends shall be designed to one or more of the following, unless otherwise specified by the user:

(a) PE valve stub-ends that conform to the applicable dimensions of ASTM D2513 or ASTM D3261

(b) PA-11 valve stub-ends that conform to the applicable dimensions of ASTM F2945 or ASTM F1733

(c) PE socket ends that conform to the applicable dimensions listed in ASTM D2683

(d) integral mechanical joints that meet the requirements of the applicable paragraphs under Joining of Materials Other Than by Welding, 49 C.F.R., §§ 192.281-192.287 (2017)

4 PRESSURE RATING

4.1 Maximum Pressure Rating

The maximum pressure rating of each valve is the valve design pressure as defined in para. 1.5 for service from −20°F to 140°F (−29°C to 60°C).

4.2 Design Pressure (19)

The design pressure of the valve shall be limited to the maximum service pressure permitted for plastic pipe as specified in Pipe Design, 49 C.F.R., § 192.123 (2017).

5 MARKING (19)

Each valve shall be clearly marked to show the following:

(a) the manufacturer's name or trademark

(b) the designation B16.40

(c) the NVS

(d) the pressure shell material designation code as specified in ASTM D2513 or ASTM F2945

(e) DRv

(f) the date each molded pressure shell part was molded. Valve shells that are not molded shall be stamped with the date of manufacture using low-stress stamping. An identifier traceable to the date of manufacture may be used as a substitute for date markings.

The markings specified in (a) and (f) shall be permanently affixed to or incorporated as part of the permanent valve identification.

Other markings may be affixed to the valve by any means, provided they do not impair the structural integrity or the operation of the valve.

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6 PRODUCTION AND QUALIFICATION TESTING

6.1 General

(a) Gas tightness of production valves shall be demonstrated by subjecting each valve to shell and seat tests in accordance with para. 6.2.

(b) Each basic valve design shall be qualified by testing randomly selected production valves in accordance with para. 6.3.

(c) Leak test fluid shall be air or other gas. During leakage testing, there shall be no visible leakage (breaking away or buildup of bubbles) as measured by the immersion or leak detection solution methods. If immersion is used, the depth from the water surface shall be no more than 12 in. (300 mm). Other means of leak detection may be used, provided they are equivalent in leak detection sensitivity.

6.2 Production Testing

6.2.1 Shell Test. Each valve shall be tested at 4 psi ± 2 psi (0.28 bar ± 0.14 bar) and at a minimum of 1.5 times the design pressure. The test pressure shall be applied to all pressure-containing areas of the valve (including stem seals and valve ends). This may require the valve to be in the partially open position. The shell test shall be conducted at a temperature of 73°F ± 15°F (23°C ± 8°C). The test fixturing shall not restrain the valve against any mode of failure or leakage. The minimum duration of each of the two shell tests shall be as shown in Table 6.2.1-1.

6.2.2 Seat Test. Each valve shall be seat closure tested at 4 psi ± 2 psi (0.28 bar ± 0.14 bar) and at a minimum of 1.5 times the valve design pressure. These pressures shall be applied successively on each side of the valve seat(s) to check the valve-sealing performance in both directions. The seat test shall be conducted at a temperature of 73°F ± 15°F (23°C ± 8°C). The seat test's fixturing shall not restrain the valve against any mode of failure or leakage. The minimum duration of each portion of the test shall be as shown in Table 6.2.1-1.

6.3 Qualification Testing

6.3.1 Operational Test. It shall be demonstrated that each nominal size of each basic valve design is capable of successfully passing the seat leakage tests of para. 6.2.2 after having completed ten fully opened/closed cycles at 73°F ± 15°F (23°C ± 8°C). The valve shall be pressurized with air or other gas to the design pressure at one port with the other port open to atmosphere before opening on each cycle. At the start of each cycle, the operating torque shall be measured and not exceed those in Table 6.3.1-1 for −20°F (−29°C).

6.3.2 Temperature Resistance. It shall be demonstrated that each nominal size of each basic valve design is capable of being operated at temperatures of −20°F ± 5°F (−29°C ± 3°C) and 140°F ± 5°F (60°C ± 3°C) without visible leakage to atmosphere and without affecting the internal seat-sealing performance of the valve.

The test method is as follows: a closed valve shall be cooled to a temperature of −20°F ± 5°F (−29°C ± 3°C) and held at that temperature for a minimum of 18 hr. The valve shall then be pressurized with air or gas to a differential pressure across the seat equal to the valve design pressure. The valve shall then be opened against the applied-differential pressure, using a torque less than or equal to that of Table 6.3.1-1 at the −20°F (−29°C) values and then closed (no differential pressure across the seat required).

The valve shall then be tested to meet the requirements of para. 6.2 while at −20°F (−29°C), except nonfreezing leak-detection agents shall be used. The valve shall be heated to a temperature of 140°F ± 5°F (60°C ± 3°C) and held at that temperature for a minimum of 18 hr. The closed valve shall then be pressurized with air or other gas to a differential pressure across the seat equal to the valve's design pressure at 140°F (60°C). The valve shall then be opened against the applied-differential pressure using a torque less than or equal to that of Table 6.3.1-1 values [140°F (60°C)] and then closed (no differential pressure across the seat required). The valve shall then be tested to and meet the requirements of para. 6.2 while at 140°F (60°C).

6.3.3 Sustained-Pressure Test. Each basic valve (19)
design shall be subjected to the sustained-pressure tests described herein to evaluate the long-term pressure integrity of the valve shell and closure elements. All valves shall be in the open position for the pressure-boundary test [see (a)] and in the closed position for the valve closure test [see (b)].

For both PE and PA-11, Table 6.3.3-1 offers two choices of pressures and duration times for the sustained pressure test. The valve manufacturer shall test for 1,000 hr at the lower listed pressures, depending on valve DR, or for 170 hr at the higher listed pressures. Either choice is valid. The valve manufacturer is not required to perform both tests. For NVS < $1\frac{1}{4}$, the sustained-pressure tests may use Table 6.3.3-1 DR 9.3 pressure values.

The valves shall not fail, as defined in ASTM D1598, when subjected to the sustained pressure test.

(a) Pressure-Boundary Test. Six samples of each basic valve design shall be connected at both ends to thermoplastic pipe of appropriate wall thickness of a length at least 5 times its outside diameter or 20 in. (510 mm), whichever is less. These assemblies shall be subjected to a sustained-pressure test chosen from the sustained test pressures and minimum durations listed in Table 6.3.3-1. The DRv for the valve shall be used in determining

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the test pressure. Failure of two of the six samples tested shall constitute failure in the test. Failure of one of the six samples tested is cause for a retest of six additional samples. Failure of one of the six samples in retest shall constitute failure in the test. Failure of a test sample shall be as defined in ASTM D1598.

(b) Valve Closure Test. One of each variation in design or material of the closure element and/or seat seals of each nominal valve size shall be tested in the closed position. One port shall be pressurized to 1.1 times the valve design pressure and the opposite port open to atmosphere. The pressure shall be maintained for a minimum of 170 hr at 176°F (80°C) or for 1,000 hr at 100°F (38°C). There shall be no evidence of leakage (breaking away of bubbles) past the closure element for the duration of the test.

At the conclusion of this test, the valve must be operable at both 0 psi (0 bar) and with a differential pressure equal to its design pressure. The valve must operate with torque less than that shown in Table 6.3.1-1, 140°F (60°C), and there must be no leakage through a closure part.

6.3.4 Flow Capacity. The shape, size, and configuration of the valve when in the fully opened position shall be designed to provide flow and head-loss coefficients specified in Table 6.3.4-1. A valve of each NVS and type shall be tested to verify the coefficient when installed in a straight run of pipe of the size and wall thickness for which the valve is designed to be conducted, following a procedure such as ANSI/ISA S75.02.

The test fluid and type of test facility and instrumentation are the responsibility of the manufacturer. Flow test reports shall be available for purchaser's review at the manufacturer's facility.

6.3.5 Impact Resistance. This test shall be performed on each NVS and type.

A valve shall not develop leakage or otherwise exhibit impairment of operation when subjected to impacts according to the following test procedure.

The valve shall be firmly supported with stem vertical while in the upright position, resting on $^3/_4$ in. (19 mm) plywood. The valve shall be conditioned for a minimum of 18 hr at a temperature of 0°F ± 5°F (−18°C ± 3°C).

An impact shall be applied to the valve stem or operating nut perpendicular to the top of the valve operating nut, using a type "B" 20-lb tup as described in ASTM D2444 dropped from a height of 3 ft (914 mm). The valve shall be impacted five consecutive times within 2 min of removing the valve from the conditioning environmental chamber. The ambient test conditions shall not exceed 88°F (31°C). Following the impacts, the valve shall be operable and subjected to the testing required by para. 6.3.2.

The entire test shall be repeated with the impacts applied at a temperature of 100°F ± 5°F (38°C ± 3°C) on a second valve that has been conditioned at that temperature for a minimum of 18 hr.

Table 6.2.1-1 Duration of Test

Nominal Valve Size	Minimum Time Duration, sec
2 and smaller	15
Over 2 to 6	30
Over 6	60

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Table 6.3.1-1 Maximum Operating Torque Values

Nominal Valve Size [Note (1)]	Maximum Operating Torque at 140°F (60°C), lbf-in. (N·m)	Maximum Operating Torque at −20°F (−29°C), lbf-in. (N·m)
½	130 (15)	390 (45)
¾	160 (18)	480 (54)
1	300 (34)	600 (68)
1¼	400 (45)	800 (90)
1½	500 (56)	1,000 (112)
2	600 (68)	1,200 (136)
3	900 (102)	1,350 (153)
4	1,200 (136)	1,800 (204)
5	1,350 (153)	2,025 (229)
6	1,500 (169)	2,250 (253)
8	2,600 (293)	3,900 (440)
10	4,000 (451)	6,000 (677)
12	6,000 (677)	9,000 (1 016)

NOTE: (1) For valves having different sized inlets and outlets, the smaller size shall determine the maximum operating torque.

(19)
Table 6.3.3-1 Sustained Test Pressures and Minimum Durations

	PE 2708 and PE 4710		PA-11	
	176°F (80°C), 1,000 hr [Note (1)]	176°F (80°C), 170 hr [Note (2)]	73°F (23°C), 1,000 hr [Note (3)]	176°F (80°C), 170 hr [Note (4)]
DR	psig (bar)	psig (bar)	psig (bar)	psig (bar)
6	232 (16.0)	268 (18.5)	1,120 (77.2)	580 (40.0)
9.3	140 (9.6)	161 (11.1)	675 (46.5)	349 (24.1)
10	129 (8.9)	149 (10.3)	622 (42.9)	322 (22.2)
11	116 (8.0)	134 (9.2)	560 (38.6)	290 (20.0)
13.5	93 (6.4)	107 (7.4)	448 (30.9)	232 (16.0)
17	73 (5.0)	84 (5.8)	350 (24.1)	181 (12.5)
21	58 (4.0)	67 (4.6)	280 (19.3)	145 (10.0)
26	46 (3.2)	54 (3.7)	224 (15.4)	116 (8.0)

GENERAL NOTES:
(a) P, psig = 2 × S/(DR − 1).
(b) This Table has two options for each material; the valve manufacturer may choose to perform long-term tests at the pressure–temperature conditions specified for 1,000 hr or alternative pressure–temperature conditions specified for 170 hr.

NOTES:
(1) PE 1,000-hr fiber stress, S = 580 psi (4.0 MPa).
(2) PE 170-hr fiber stress, S = 670 psi (4.5 MPa).
(3) PA-11 1,000-hr fiber stress, S = 2,800 psi (19.3 MPa).
(4) PA-11 170-hr fiber stress, S = 1,450 psi (10.0 MPa).

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Table 6.3.4-1 Flow and Head Loss Coefficients

Nominal Valve Size [Note (1)]	Coefficients			
	Minimum Gas Flow at Reference Condition, ft^3/hr (m^3/h) [Note (2)]	Minimum Flow Coefficient, C_v [Note (3)]	Maximum Head Loss in Velocity Heads, K [Note (4)]	Maximum Equivalent Length of SDR 11 Pipe, ft (m)
$^1/_2$	190 (5.4)	6	5.0	10 (3.0)
$^3/_4$	290 (8.2)	10	5.0	15 (4.6)
1	600 (17.0)	20	3.0	12 (3.7)
$1^1/_4$	1,200 (34.0)	39	2.0	11 (3.4)
$1^1/_2$	1,500 (42.5)	51	2.0	13 (4.0)
2	2,400 (68.0)	80	2.0	17 (5.2)
3	6,000 (170.0)	200	1.5	21 (6.4)
4	9,900 (280.0)	330	1.5	28 (8.5)
5	15,000 (425.0)	440	1.5	37 (11.3)
6	19,000 (538.0)	650	1.9	57 (17.4)
8	36,000 (1 020.0)	1,200	1.5	61 (18.4)
10	60,000 (1 700.0)	2,000	1.3	69 (20.8)
12	90,000 (2 550.0)	3,000	1.1	74 (22.5)

NOTES:

(1) For valves having different-sized inlets and outlets, the smaller size shall determine the coefficient.

(2) Minimum gas flow in standard cubic feet per hour (cubic meters per hour) with the valve in the fully opened position at an inlet pressure of 0.5 psi (0.035 bar), 70°F (21.1°C), 0.64 specific gravity, and 0.3 in. (7.6 mm) water column net valve pressure drop, assuming valve in SDR 11 pipe.

(3) C_v = flow of water at 60°F (16°C), in U.S. gallons per minute, that a valve will pass at a pressure drop of 1.0 psi (0.07 bar).

(4) K = head loss coefficient consistent with the following formula:

$$h_L = K(V^2/2g_c);\ K = (29.9d^2/C_v)^2$$

where

d = pipe inside diameter for which the value of fluid velocity, V, is associated, in. (mm)

g_c = 32.2 ft/sec^2 (9.81 m/s^2)

h_L = head loss produced by valve, ft (m)

V = fluid velocity in pipe, ft/sec (m/s)

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MANDATORY APPENDIX I
VALVE DESIGN PRESSURE

The valve design pressure, p, for the various materials and DR equivalents is to be calculated as follows:

$$p = 2SF/(\mathrm{DRv} - 1),\ \mathrm{psi}\ (\mathrm{bar})$$

where

DRv = valve's dimensional ratio (DR) equivalent
F = a service (design) derating factor (see example below)
S = hydrostatic design basis (HDB) at the maximum expected application use temperature, as listed by the PPI Hydrostatic Stress Board and as published in PPI TR-4. Methods of determining HDB are described in ASTM D2837.

EXAMPLE: If the material is PE 2708, the expected maximum use temperature is 73°F (23°C), and the valve's DR equivalent is 11; from PPI TR-4, the material's HDB, S, at 73°F (23°C) is 1,250 psi (8.6 MPa). The design factor 0.32, F, used for this example is taken from 49 C.F.R., § 192.121 (2017). Then

$$p = 2 \times 1{,}250 \times 0.32/(11 - 1) = 80\ \mathrm{psig}$$

NOTE: 80 psig is equivalent to 5.5 bar.

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MANDATORY APPENDIX II
REFERENCES

The following is a list of publications referenced in this Standard.

ANSI/ISA S75.02-1996, Control Valve Capacity Test Procedure[1]
Publisher: International Society of Automation (ISA), 67 T. W. Alexander Drive, P.O. Box 12277, Research Triangle Park, NC 27709 (www.isa.org)

ASTM D1598–15a, Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
ASTM D2444–18, Standard Practice for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
ASTM D2513–16a, Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
ASTM D2683–14, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D2837–13e1, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
ASTM D3261–16, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM E29–13, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
ASTM F1733-13, Standard Specification for Butt Heat Fusion Polyamide (PA) Plastic Fitting for Polyamide (PA) Plastic Pipe and Tubing
ASTM F2945-15, Standard Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings
Publisher: American Society for Testing and Materials (ASTM International), 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 (www.astm.org)

U.S. Department of Transportation. "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Standards," *Code of Federal Regulations*, Title 49 (2017)
Publisher: U.S. Government Publishing Office (GPO), 732 N. Capitol Street NW, Washington, DC 20401 (www.govinfo.gov)

ISO 9000:2015, Quality management systems — Fundamentals and vocabulary[1]
ISO 9001:2015, Quality management systems — Requirements[1]
ISO 9004:2018, Quality management — Quality of an organization — Guidance to achieve sustained success[1]
Publisher: International Organization for Standardization (ISO), Central Secretariat, Chemin de Blandonnet 8, Case Postale 401, 1214 Vernier, Geneva, Switzerland (www.iso.org)

PPI TR-4-2017, HDB/HDS/SDB/PDB/MRS Listed Materials
Publisher: Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062 (www.plasticpipe.org)

[1] May also be obtained from American National Standards Institute, 25 West 43rd Street, New York, NY 10036.

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