Designation: F645 – 15a

Standard Guide for Selection, Design, and Installation of Thermoplastic Water-Pressure Piping Systems[1]

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1. Scope*

1.1 This guide is intended for use in the selection, design, and installation of thermoplastic water systems for use outside buildings. For specific projects, a thorough review of this guide is recommended for the purpose of selecting specific materials, methods of joining, system design factor, and any special procedures deemed necessary to assure a satisfactory system.

1.2 It is recommended that governing codes and project specifications be consulted prior to the use of this guide. Nothing in this guide should be construed as recommending practices or systems at variance with governing codes and project specifications.

1.3 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard. The pipe, fittings, and joining materials shall meet the requirements of one or more of the following component product standards listed in 1.3.1 through 1.3.4 to the extent applicable. Those pipe standards followed by (*a*) are outside diameter-controlled pipes. Those followed by (*b*) are inside diameter-controlled pipes.

1.3.1 *For poly(vinyl chloride) (PVC) plastic piping components:*

Title of Specification	ASTM Designation
Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120 (*a*)	D1785
Poly(Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR) (*a*)	D2241
Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80	D2464
Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40	D2466
Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80	D2467
Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings	D2564
Bell-End Poly(Vinyl Chloride) (PVC) Pipe (*a*)	D2672
Poly(Vinyl Chloride) (PVC) Plastic Tubing (*a*)	D2740
Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Line Couplings	D3036
Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals	D3139
Elastomeric Seals (Gaskets) for Joining Plastic Pipe	F477
PVC and ABS Injected Solvent Cemented Plastic Pipe Joints	F545

1.3.2 *For Chlorinated Poly(Vinyl chloride) (CPVC) plastic piping components:*

Title of Specification	ASTM Designation
Chlorinated Poly(Vinyl chloride) (CPVC) Plastic Pipe, Schedules 40 and 80 (a)	F441/F441M
Chlorinated Poly(Vinyl chloride) (CPVC) Plastic Pipe Fittings, Schedule 80	F439
Solvent Cements for Chlorinated Poly(Vinyl chloride) (CPVC) Plastic Pipe and Fittings	F493

1.3.3 *For polyethylene (PE) plastic piping components:*

Title of Specification	ASTM Designation
Polyethylene (PE) Plastic Pipe, (SDR-PR) (*b*)	D2239
Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe	D2609
Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe (*a*)	D2683
Polyethylene (PE) Plastic Tubing (*a*)	D2737
Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter (*a*)	D3035
Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing	D3261

1.3.4 *For poly(vinyl chloride) (PVC) and polyethylene (PE) Plastic Piping Components Issued By the American Water Works Association:*

C900 Poly(Vinyl Chloride) (PVC) Pressure Pipe, 4-inch through 12-inch, for Water (a)

C901 Polyethylene (PE) Pressure Pipe, Tubing and Fittings, ½-inch through 3-inch, for Water

1.3.5 Pipes with wall thicknesses less than 1.50 mm (0.06 in.) are not recommended.

1.4 *Other Joining Devices*—Joining devices other than those covered by the listed standards may be selected by the user on the basis of his own engineering evaluation and service experience.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

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[1] This guide is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.61 on Water.

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*A Summary of Changes section appears at the end of this standard

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1600 Terminology for Abbreviated Terms Relating to Plastics

D1784 Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

D1785 Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

D2239 Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter

D2241 Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

D2464 Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

D2466 Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

D2467 Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

D2564 Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

D2609 Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe

D2672 Specification for Joints for IPS PVC Pipe Using Solvent Cement

D2683 Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing

D2737 Specification for Polyethylene (PE) Plastic Tubing

D2740 Specification for Poly(Vinyl Chloride) (PVC) Plastic Tubing (Withdrawn 1989)[3]

D2774 Practice for Underground Installation of Thermoplastic Pressure Piping

D2855 Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings

D3035 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter

D3036 Specification for Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Line Couplings (Withdrawn 1985)[3]

D3139 Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

D3261 Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials

F412 Terminology Relating to Plastic Piping Systems

F439 Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

F441/F441M Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F493 Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

F545 Specification for PVC and ABS Injected Solvent Cemented Plastic Pipe Joints (Withdrawn 2001)[3]

F1498 Specification for Taper Pipe Threads 60° for Thermoplastic Pipe and Fittings

2.2 *American Water Works Association Standards*[4]:

C651 Disinfecting Water Mains

C900 Poly(Vinyl Chloride) (PVC) Pressure Pipe, 4-Inch Through 12-Inch, for Water

C901 Polyethylene (PE) Pressure Pipe, Tubing and Fittings, ½-Inch Through 3-Inch, for Water

2.3 *Plastics Pipe Institute Report:*[5]

PPI-TR 3 HDB/PDB/SDB/MRS Policies

PPI-TR 4 HDB/SDB/PDB/MRS Listed Materials

PPI-TR 9 Recommended Design Factors and Design Coefficients for Thermoplastic Pressure Pipe

2.4 *NSF Standards:*

NSF/ANSI Standard No. 14 for Plastic Piping Components and Related Materials[6]

NSF/ANSI Standard No. 61 for Drinking Water Systems Components—Health Effects[6]

2.5 *Uni-Bell PVC Pipe Association*[7]

Uni-Bell Handbook of PVC Pipe , Chapter VIII, Table 8.7

3. Terminology

3.1 Definitions are in accordance with Terminology F412 and abbreviations are in accordance with Terminology D1600 and Symbols unless otherwise specified.

3.2 *relation between standard dimension ratio, hydrostatic design stress, and pressure rating*—the following expression is used in this guide to relate standard dimension ratio, hydrostatic design stress, and pressure rating:

$$2S/P = R - 1 \text{ or } 2\,S/P = (D/t) - 1 \quad (1)$$

where:

S = hydrostatic design stress, MPa (or psi),
P = pressure rating, MPa (or psi),
D = average outside diameter, mm (or in.),
t = minimum wall thickness, mm (or in.), and
R = standard thermoplastic pipe dimension ratio also known as SDR or SIDR, whichever is applicable.
d = average inside diameter, mm (or in.)—substitute d for D in equations and change minus sign to plus.

4. Significance and Use

4.1 The requirements of this specification are intended to provide information to select, design and install thermoplastic,

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, http://www.awwa.org.

[5] Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, http://www.plasticpipe.org.

[6] Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, http://www.nsf.org.

[7] Available from UNI-BELL PVC Pipe Association, 711 LBJ Freeway, Suite 1000, Dallas, TX 75234, http://www.uni-bell.org

water-pressure piping systems for use outside buildings. Materials covered in this specification are Poly(Vinyl Chloride) (PVC) and Polyethylene (PE) plastic pipe fittings.

5. System Pressure Design

5.1 The maximum pressure ratings in Tables 1-7 make allowance for normal operating conditions, reasonable installation procedures, good handling, good joining workmanship, operating temperatures below 27°C (80°F), and surges likely to be encountered at water flow velocities up to 5 ft/s (1.5 m/s). Tubing Sizes with pressure ratings less than 160 psi are listed in the tables. (Note 1, Note 2).

NOTE 1—See Marking section and appendix of applicable pipe specification for marking pipe with pressure ratings lower than the maximum values given in Tables 1-7.

NOTE 2—Changes to Specification D3350 and PPI-TR 3 led to changes in thermoplastic materials designation codes, resulting in materials designation PE 2406 being superseded by materials designations PE 2606 and PE 2708, materials designations PE3306 and PE 3406 being superseded by PE 3606 and materials designation PE 3408 being superseded by materials designations PE 3608, PE 3708, PE 3710, PE 4608, PE 4708, and PE 4710. Recognizing that a period of time is necessary for the dissemination of information and to update specifications and literature, during the transitional period, product markings that include both older and newer materials designations, for example PE 2406/PE 2606, may occur.

5.2 The maximum safe water velocity in a thermoplastic piping system depends on the specific details of the system and the operating conditions. In general, 5 ft/s (1.5 m/s) is considered to be safe. Higher velocities may be used in cases where the operating conditions can be controlled or a higher design factor than 2.0 is used, or both. The total pressure in the system at any time (operating plus surge or water hammer) due to surges or water hammers shall not exceed 150 % of the pressure rating of the system.

5.3 The maximum pressure ratings in Tables 1-7 make some allowance for surge and water hammer. However, when excessive surges and water hammer are likely to be encountered, extra allowance should be made or protective devices installed. The surge or water hammer resulting from rapid flow stoppage may be calculated by means of the following equation:

$$p = V\sqrt{\frac{4{,}033}{\left(1+\dfrac{300\,000d}{Et}\right)}} \tag{2}$$

where:

p = peak water surge pressure, psi,
E = modulus of elasticity of the pipe material, psi,
d = inside diameter of the pipe, inclusive, in.,
t = wall thickness, in., and
V = water velocity, ft/s.

5.4 The pressure rating of properly solvent-cemented joints made in accordance with 8.2.1 is the same as the pipe joined after reasonable time for cure of the joint. The pressure rating of well-made heat-fused joints made in accordance with 8.2.1 is the same as the pipe joined, after the material in the joint has cooled to the pipe temperature.

5.5 PVC threaded pipe shall be pressure rated at 50 % of that of nonthreaded pipe (see Specification F1498). Pipe with wall thicknesses less than those of Schedule 80 pipe shall not be threaded. PE pipe shall not be threaded.

5.6 Joints and the allied fittings made by means other than those covered above shall be pressure-rated by engineering evaluations and service experience by either the design engineer or user, or both. The recommendations of the manufacturers should also be considered (see Specification D3139).

5.7 Allowance shall be made for operating conditions in which the water will be above 27°C (80°F) under normal service conditions. Hydrostatic design stresses for thermoplastic pipe materials are given in PPI-TR 4, Recommended

TABLE 1 Maximum Water Pressure Ratings at 23°C (73°F) for Schedule 40 PVC Plastic Pipe (Specification D1785)

Nominal Pipe Size, in.	PVC 1120 PVC 1220 PVC 2120	Pressure Rating, psi[A]		
		PVC 2116	PVC 2110	PVC 2112
½	600	480	300	370
¾	480	390	240	300
1	450	360	220	280
1¼	370	290	180	230
1½	330	260	170	210
2	280	220	140	170
2½	300	240	150	190
3	260	210	130	160
3½	240	190	120	150
4	220	180	110	140
5	190	160	100	120
6	180	140	90	110
8	160	120	80	100
10	140	110	NPR[B]	90
12	130	110	NPR	80

[A] These maximum pressure ratings apply only to unthreaded pipe. The industry recommends against the use of threaded PVC plastic pipe in Schedule 40 wall thickness in nominal pipe sizes 6 in. and smaller. See applicable ASTM standard for code designation, for example, PVC 1120. Pipe with pressure ratings less than 0.34 MPa (50 psi) is not recommended for use in pressure systems.
[B] NPR = not pressure rated.

TABLE 2 Maximum Water Pressure Ratings at 23°C (73°F) for Schedule 80 PVC Plastic Pipe (Specification D1785)

Nominal Pipe Size in.	Pressure Rating, psi[A]							
	PVC 1120, PVC 1220, and PVC 2120		PVC 2116		PVC 2110		PVC 2112	
	Unthreaded	Threaded	Unthreaded	Threaded	Unthreaded	Threaded	Unthreaded	Threaded
¼	850	420	680	340	420	210	530	260
¾	690	340	550	280	340	170	430	210
1	630	320	500	250	320	160	390	200
1¼	520	260	420	210	260	130	320	160
1½	470	240	380	190	240	120	290	150
2	400	200	320	160	200	100	250	130
2½	420	210	340	170	210	110	260	130
3	370	190	300	150	190	90	230	120
3½	350	170	280	140	170	90	220	110
4	320	160	260	130	160	80	200	100
5	290	140	230	120	140	NPR[B]	180	90
6	280	140	220	110	140	NPR	170	90
8	250	120	200	100	120	NPR	150	80
10	230	120	190	90	120	NPR	150	NPR
12	230	110	180	90	110	NPR	140	NPR

[A] See applicable ASTM standard for code designation, for example, PVC 1120. Pressure ratings are lower at elevated temperatures. Pipe with pressure ratings less than 0.34 MPa (50 psi) is not recommended for use in pressure systems.
[B] NPR, not pressure rated.

TABLE 3 Maximum Water Pressure Ratings at 23°C (73°F) for Schedule 120 PVC Plastic Pipe (Specification D1785)

Nominal Pipe Size,	Pressure Rating, psi[A]							
	PVC 1120, PVC 1220, PVC 2120		PVC 2116		PVC 2110		PVC 2112	
	Unthreaded	Threaded	Unthreaded	Threaded	Unthreaded	Threaded	Unthreaded	Threaded
½	1010	510	810	410	510	250	630	320
¾	770	390	620	310	390	190	480	240
1	720	360	570	290	360	180	450	220
1¼	600	300	480	240	300	150	370	190
1½	540	270	430	210	270	130	340	170
2	470	240	380	190	240	120	290	150
2½	470	230	370	190	230	120	290	150
3	440	220	360	180	220	110	280	140
3½	380	190	310	150	190	100	240	120
4	430	220	340	170	220	110	270	130
5	400	200	320	160	200	100	250	120
6	370	190	300	150	190	90	230	120
8	380	180	290	140	180	90	230	110
10	370	180	290	140	180	90	230	110
12	340	170	270	140	170	80	210	110

[A] See applicable ASTM standard for code designation, for example, PVC 1120. Pressure ratings are lower at elevated temperatures.

Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings Compounds, a report issued at intervals by the Plastics Pipe Institute.

5.8 In piping system design the selection of a design or safety factor depends on the operating conditions that will be encountered. It may be necessary to use pressure ratings lower than the pressure ratings listed in Tables 1-7 when the following are likely to be encountered: (*1*) surges or water hammer, (*2*) cyclic pressure oscillations, (*3*) air pockets, (*4*) quick-closing valves, (*5*) pumps with more capacity than the lines can deliver, (*6*) flow velocities more than 5 ft/s, and (*7*) similar factors or combinations of (1) through (6). This will result in using pipe and fittings with heavier walls. Consult manufacturers for specific recommendations. Operating temperatures above 23°C (73°F) will make the pipe more flexible and will lower both the short-term and long-term hydrostatic strengths. The designer of the piping system shall use any additional design (safety) factors that are deemed necessary to cover any unusual or special conditions that may be encountered on a specific job. For PVC pipe temperature correction factors (stress and modulus of elasticity) see Table 9. The stress correction factor multiplied by the maximum water pressure rating at 73°F will yield a new maximum water pressure rating for a given temperature.

5.9 Pressure surges may adversely affect the long-term performance of system components and shall be kept to the absolute minimum practical. Where surges are anticipated due to the action of pressure regulating valves, pumps, and other operating equipment, the manufacturer shall be consulted for recommendations.

TABLE 4 Standard Thermoplastic Pipe Dimension Ratios (SDR) and Maximum Water Pressure Ratings (PR) at 23°C (73°F) for Nonthreaded PVC Plastic Pipe (Specification D2241)

Standard Dimension Ratio (SDR)	PVC Pipe Materials[A]			
	PVC 1120, PVC 1220, PVC 2120	PVC 2116	PVC 2112	PVC 2110
	Pressure Rating, psi[B]			
13.5	315	250	200	160
17	250	200	160	125
21	200	160	25	100
26	160	125	100	NPR[C]
32.5[D]	125	100	NPR	NPR
Pressure Rating, psi	Standard Dimension Ratio (SDR)			
315	13.5	...	...	...
250	17	13.5	...	...
200	21	17	13.5	...
160	26	21	17	13.5
125	32.5	26	21	17
100	NPR	32.5	26	21

[A] See applicable ASTM standard for code designation, for example, PVC 1120.
[B] These maximum pressure ratings do not apply to threaded pipe. pressure ratings are lower at elevated temperatures. Pipe with pressure ratings less than 0.34 MPa (50 psi) is not recommended for use in pressure systems.
[C] NPR = not pressure rated.
[D] Available only in nominal pipe size diameters from 3 to 4 in.

TABLE 5 Standard Thermoplastic Pipe Dimension Ratios (SDR) and Maximum Water Pressure Ratings (PR) at 23°C (73°F) for SDR-PR PE Plastic Pipe, Inside Diameter Control SDIR (Specification D2239)

Standard Inside Dimension Ratio (SIDR)	PE Pipe Materials[A]			
	PE3408	PE 3406, PE 3306, and PE 2306	PE 2305	PE 1404
	Pressure Rating, psi[B]			
5.3	250	200	160	125
7	200	160	125	100
9	160	125	100	80
11.5	125	100	80	NPR[C]
15	100	80	NPR	NPR
Pressure Rating, psi	Standard Inside Dimension Ratio (SIDR)			
250	5.3	...	...	...
200	7	5.3	...	...
160	9	7	5.3	...
125	11.5	9	7	5.3
100	15	11.5	9	7
80	19	15	11.5	9

[A] See applicable ASTM standard for code designation, for example, PE 3306, pressure ratings are lower at elevated temperatures.
[B] These maximum pressure ratings apply only to unthreaded pipe. The industry recommends against the use of threaded PE plastic pipe. Pipe with pressure ratings less than 0.34 MPa (50 psi) is not recommended for use in pressure systems.
[C] NPR = not pressure rated.

6. PVC System Design for Above Ground Installation with Solvent Cemented Joints

6.1 *PVC Thermal Expansion:*

6.1.1 When designing above ground solvent cemented PVC piping systems, thermal expansion/contraction shall be considered. Expansion/contraction along the longitudinal axis can be significant and is dependent on the coefficient of thermal expansion and the change in temperature. If the piping system is restrained, the thrust load generated by large diameter pipe can be very high. Thermal expansion, ΔL, can be found in Table 8 or shall be calculated by the following equation:

$$\Delta L = 12\alpha L(\Delta T) \quad (3)$$

TABLE 6 Maximum Water Pressure Ratings (PR) at 23°C (73°F) for DR-PR PE Plastic Pipe Outside Diameter Control (Specification D3035)

Dimension Ratio	PE Pipe Materials[A]			
	PE3710, PE4710	PE 2708, PE3608, PE3708, PE4608, and PE4708	PE 2606	PE 1404
	Pressure Rating, psi[B]			
7	333	267	210	133
9	250	200	158	100
9.3	241	193	152	96
11	200	160	126	80
13.5	160	128	100	64
15.5	138	110	87	55
17	125	100	79	50
21	100	80	63	NPR[C]
26	80	64	50	NPR
32.5	63	51	NPR	NPR
Pressure Rating, psi	Standard Dimension Ratio (SDR)			
333	7	...	...	...
267	...	7	...	...
250	9	...	...	...
241	9.3	...	...	...
210	...	...	7	...
200	11	9	...	...
193	...	9.3	...	...
160	13.5	11	...	...
158	...	...	9	...
152	...	...	9.3	...
138	15.5	...	...	...
133	...	...	...	7
128	...	13.5	...	...
126	...	...	11	...
125	17	...	13.5	...
110	..	15.5	...	...
100	21	17	...	9
96	...	...	...	9.3
80	26	21	...	11
64	...	26	...	13.5
63	32.5	...	21	...
55	...	...	...	15.5
51	...	32.5	...	...
50	...	...	26	17

[A] See applicable ASTM standard for code designation, for example, PE 3608, pressure ratings are lower at elevated temperatures.
[B] These maximum pressure ratings apply only to unthreaded pipe. The industry recommends against the use of threaded PE plastic pipe. Pipe with pressure ratings less than 0.34 MPa (50 psi) is not recommended for use in pressure systems.
[C] NPR = not pressure rated.

where:

ΔL = change in pipe length, *in.*
α = coefficient of thermal expansion
= 3.0×10^{-5}, *in./in.* °F
L = length of pipe run, *ft*
ΔT = change in temperature, °F

6.2 *PVC Expansion Loops and Offset Lengths:*

6.2.1 When designing PVC piping systems with solvent cemented joints in long straight runs exposed to large temperature differentials, it is necessary to compensate for thermal expansion/contraction. This can be accomplished by expansion loops, offsets or changes in direction. (See Fig. 1.) Expansion loops and offset lengths shall be calculated from Eq 4. Table 9 (Temperature Corrections for PVC Allowable Stress and Modulus of Elasticity) provides design stress and corresponding short-term modulus of elasticity values derated for various temperatures. For calculations, use derated stress and modulus values for the maximum expected temperatures. Change in length, ΔL, found in Table 8 can be used for Eq 4 or shall be calculated from Eq 3 using the piping systems maximum temperature minus minimum expected temperatures. Expansion loops, offsets, and changes of direction shall be constructed with straight pipe and solvent cemented 90° elbows. Guides and hangers shall be nonbinding to allow pipe to float. Offset length, L_o, is not linear; therefore, each piping length requires individual calculations.

TABLE 7 Standard Thermoplastic Pipe Dimension Ratios (SDR) and Maximum Water Pressure Ratings (PR) at 23°C (73°F) PVC and PE (Specifications D2740 and D2737)

ASTM Tubing Standard	Standard Dimension Ratio (SDR)	Material Designation[A]	Pressure Rating, psi[B]
D2740	26	PVC 1120	160
PVC 1220			
D2740	21	PVC 2116	160
D2740	17	PVC 2112	160
D2740	13.5	PVC 2110	160
D2737	7.3	PE 2305	160
		PE 2306	
D2737	9	PE 3306	160
		PE 3406	

[A] See applicable ASTM standard for code designation, pressure ratings are lower at elevated temperatures.
[B] These maximum pressure ratings do not apply to threaded tubing. The industry recommends against the use of threaded tubing sizes.

TABLE 8 Thermal Expansion ΔL (in), PVC Pipe (12454)

Temp/ Change ΔT °F	Length of Pipe Run, L (ft)									
	10	20	30	40	50	60	70	80	90	100
30	0.11	0.22	0.32	0.43	0.54	0.65	0.76	0.86	0.97	1.08
40	0.14	0.29	0.43	0.58	0.72	0.86	1.01	1.15	1.30	1.44
50	0.18	0.36	0.54	0.72	0.90	1.08	1.26	1.40	1.62	1.80
60	0.22	0.43	0.65	0.86	1.08	1.30	1.51	1.73	1.94	2.16
70	0.25	0.50	0.76	1.01	1.26	1.51	1.76	2.02	2.27	2.52
80	0.29	0.58	0.86	1.15	1.44	1.73	2.02	2.30	2.59	2.88
90	0.32	0.65	0.97	1.30	1.62	1.94	2.27	2.59	2.92	3.24
100	0.36	0.72	1.03	1.44	1.80	2.16	2.52	2.88	3.24	3.60

TABLE 9 Temperature Corrections for PVC (12454) Allowable Stress and Modulus of Elasticity

Temperature		Correction Factor[A]	Allowable Stress	Correction Factor[B]	Modulus of Elasticity (psi)
°F	°C				
73	(23)	1.00	2,000	1.00	400,000
80	(27)	0.88	1,760	0.97	388,000
90	(32)	0.75	1,500	0.93	372,000
100	(38)	0.62	1,240	0.88	352,000
110	(43)	0.50	1,000	0.84	336,000
120	(49)	0.40	800	0.79	316,000
130	(54)	0.30	600	0.75	300,000
140	(60)	0.22	440	0.70	280,000

[A] Stress correction factors are also applied to pipe pressure ratings for elevated temperature compensation (PPI-TR 9/2002).
[B] Modulus of Elasticity correction factors (Uni-Bell Handbook of PVC Pipe, 2001, Chapter VIII, table 8.7)

$$L_o = \left(\frac{3E}{2S}\right)^{\frac{1}{2}} (D_o \Delta L)^{\frac{1}{2}} \quad (4)$$

L_o = Offset and Loop lengths, *in.*
E = Modulus of Elasticity at maximum system temperature from Table 9, *lb/in.*^{2}
S = Allowable stress at maximum system temperature from Table 9, *lb/in.*^{2}
D_o = Pipe outside diameter, in ΔL
ΔL = Change in length, from Table 8 or calculated using Eq 3, where α= 3.0 x 10^{-5}, *in./in. °F*, thermal expansion, *in.*

6.3 *PVC Support Spacing:*

6.3.1 Above ground installations of PVC piping systems shall provide sufficient support to avoid excessive stresses and sagging. Horizontal runs require the use of hangers or supports spaced at proper intervals. Support spacing is dependent on material properties (modulus of elasticity) and air or system temperature, or both.

6.3.1.1 This only applies to solvent cemented joint assemblies and not for gasketed joints. Mid-span appurtenances will require special attention. When installed outside, precautions shall be taken to provide protection against excessive heat and long term UV exposure. Pipe support spacing calculated in Table 10 is for water filled PVC pipe. For conveying other

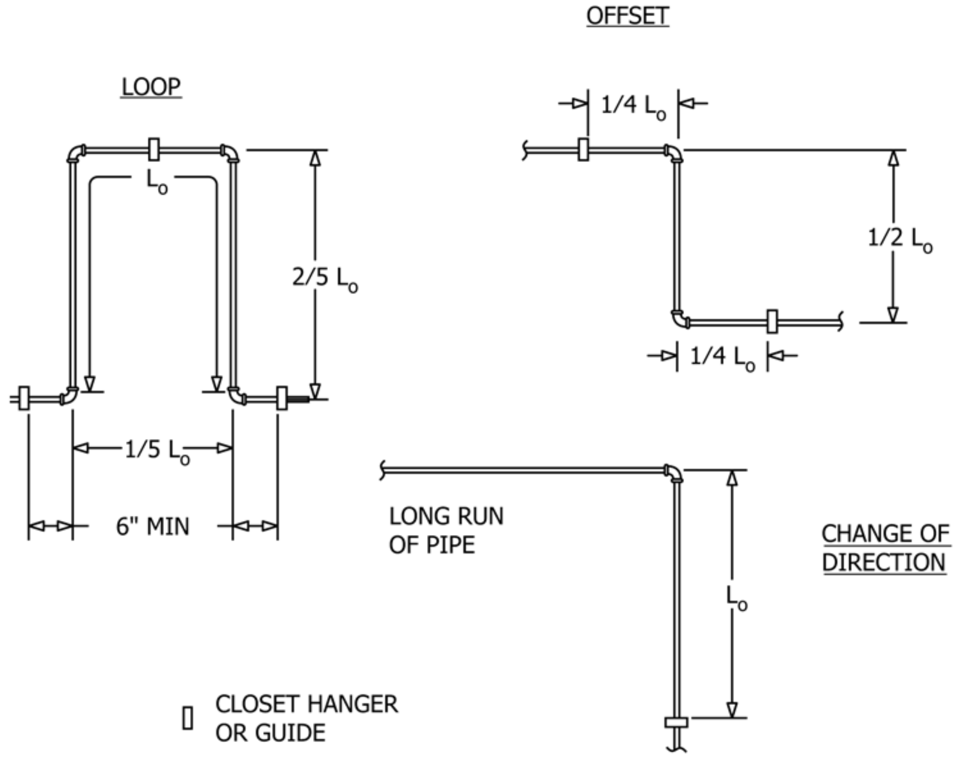

FIG. 1 Methods for Controlling Expansion/Contraction

TABLE 10 Water-Filled PVC (12454) Pipe Support Spacing / (ft)[A,B]

Pipe Size	Schedule 40			Schedule 80		
	73°F	100°F	140°F	73°F	100°F	140°F
½	4	3-¾	3-½	4	4	3-¾
¾	4-¼	4-¼	4	4-¼	4-¼	4
1	4-¾	4-½	4-¼	5-½	5-¼	5
1¼	5-¼	5	4-¾	5-½	5-¾	5
1½	5-½	5-¼	5	5-¾	5-½	5-¼
2	6	5-¼	5-½	6-¼	6	5-¾
3	7-¼	7	6-½	7-½	7-¼	7
4	8	7-¾	7-¼	8-½	8-¼	7-¾
6	9-¼	9	8-½	10	9-¾	9-¼
8	10¼	10	9-½	11-¼	10-¾	10-¼
10	11-¼	10-¾	10-¼	12-½	12	11-¼
12	12	11-¾	11	13-½	13	12-¼

[A] The industry has not yet agreed to a specific numerical value to use for long term or creep modulus for PVC in bending. The equation presented is this standard for pipe support spacing is based on more than 35 years of historical design experience. Regardless of modulus used to calculate support spacing, some additional deflection will occur over time

[B] Support spaces (*l*) are rounded off.

fluids with significantly greater specific gravities, W_f (fluid weight) will require new calculations.

6.3.1.2 Calculations of allowable support spacing shall be based upon the short-term modulus (400,000 psi for PVC cell class 12454, Specification D1784) (See table footnote A from Table 10) and midspan deflection (y), limited to 0.10-in. based on (Eq 6). Support spacing shall be calculated by the following equation:

$$l = 2.07\left(\frac{EI}{W_t}\right)^{\frac{1}{4}} \tag{5}$$

Derived from the following equation for a continuous beam with equal unlimited spans, uniformly loaded and simply supported.

$$y = .00541\frac{w_t\, l^4}{EI} \tag{6}$$

where:

y = deflection of pipe assumed to be 0.10-in.
l = span length, in.
E = modulus of elasticity at system temperature, psi

I = pipe moment of inertia, in^4
wt = weight-total, pipe + water, lb.
= $w_p + w_w = .0284\left[\left(D_o^{\,2} - D_i^{\,2}\right) sp.gr + D_i^{\,2}\right]$
$sp.gr$ = specific gravity of the pipe material

Use the modulus of elasticity at the maximum system operating temperature (Table 9) when calculating support spacing.

7. CPVC 4120-05 (Schedule 80) System Design for Above Ground Installation with Solvent Cemented Joints

7.1 *CPVC Thermal Expansion:*

7.1.1 When designing above ground solvent cemented CPVC piping systems, thermal expansion/contraction shall be considered. Expansion/contraction along the longitudinal axis can be significant and is dependent on the coefficient of thermal expansion and the change in temperature. If the piping system is restrained, the thrust load generated by large diameter pipe can be very high. Thermal expansion, ΔL, can be found in Table 11 or shall be calculated using Eq 3.

ΔL = change in pipe length, *in.*
α = coefficient of thermal expansion (for use in Eq 3) 3.4×10^{-5} , *in/in °F*
L = length of pipe run, *ft*
ΔT = change in temperature, °F

7.2 *CPVC 4120-05 Expansion Loops and Offset Lengths:*

7.2.1 When designing CPVC-05 piping systems with solvent cemented joints in long straight runs exposed to large temperature differentials, it is necessary to compensate for thermal expansion/contraction. This can be accomplished by expansion loops, offsets or changes in direction (See Fig. 1). Expansion loops and offset lengths shall be calculated from Eq 4. Table 12 (Temperature Corrections for CPVC-05 Allowable Stress and Modulus of Elasticity) provides design stress and corresponding short-term modulus of elasticity values derated for various temperatures. For calculations, use derated stress and modulus values for the maximum expected temperatures. Change in length, ΔL, found in Table 11 shall be used in Eq 4 or shall be calculated from Eq 3 using the piping systems maximum temperature minus minimum expected temperatures. Expansion loops, offsets, and changes of direction shall be constructed with straight pipe and solvent cemented 90° elbows. Guides and hangers shall be nonbinding to allow pipe to float. Offset length, L_o, is not linear; therefore, each piping length requires individual calculations. See Eq 4 for calculating expansion loops and offset lengths.

TABLE 12 Temperature Corrections Factors for CPVC 4120-05 (23447) Allowable stress and Modulus of Elasticity

Temperature °F	(°C)	Correction Factor[A]	Allowable Stress (S) (psi)	Correction Factor	Modulus of Elasticity (psi)
73	(23)	1.00	2000	1.00	423,000
80	(27)	0.96	1920	0.98	415,000
90	(32)	0.91	1820	0.94	398,000
100	(38)	0.82	1640	0.91	385,000
110	(43)	0.74	1480	0.87	368,000
120	(49)	0.65	1300	0.84	355,000
130	(54)	0.57	1140	0.81	343,000
140	(60)	0.50	1000	0.78	330,000
150	(67)	0.45	900	0.74	313,000
160	(71)	0.40	800	0.71	300,000
170	(77)	0.32	640	0.67	283,000
180	(82)	0.25	500	0.64	271,000
190	(88)	0.22	440	0.61	258,000
200	(94)	0.20	400	0.57	241,000

[A] Stress correction factors are also applied to CPVC 4120-05 pipe pressure ratings for elevated temperature compensation.

L_o = Offset and Loop lengths, *in.*
E = Modulus of Elasticity at maximum system temperature from Table 12, *lb/in.*^{2}
S = Allowable stress at maximum system temperature from Table 12, *lb/in.*^{2}
D_o = Pipe outside diameter, *in.*
ΔL = Change in length, from Table 11 or calculated using Eq 3, where $\alpha = 3.4 \times 10^{-5}$, *in/in °F*, thermal expansion, *in.*

7.3 *CPVC 4120–05 (Schedule 80) Support Spacing:*

7.3.1 Above ground installations of CPVC-05 piping systems shall provide sufficient support to avoid excessive stresses and sagging. Horizontal runs require the use of hangers or supports spaced at proper intervals. Support spacing is dependent on material properties (modulus of elasticity) and air and/or system temperature, or both.

7.3.1.1 This only applies to solvent cemented joint assemblies and not for gasketed joints. Mid-span appurtenances will require special attention. When installed outside, precautions shall be taken to provide protection against excessive heat and long term UV exposure. Pipe support spacing calculated in Table 13 is for water filled CPVC-05 pipe. For conveying other fluids with significantly greater specific gravities, W_f (fluid weight) will require new calculations.

7.3.1.2 Calculations of allowable support spacing shall be based upon the short-term modulus (430,000 psi for CPVC 4120-05 cell class 23447, Specification D1784) (See footnote A from Table 13) and midspan deflection (y), limited to

TABLE 11 Thermal Expansion ΔL (in.), CPVC 4120–05 Pipe[A]

Temp. Change ΔT °F	Length of Pipe Run in Feet (L) 10	20	30	40	50	60	70	80	90	100
30	0.12	0.24	0.37	0.49	0.61	0.73	0.86	0.98	1.10	1.22
40	0.16	0.33	0.49	0.65	0.82	0.98	1.14	1.31	1.47	1.63
50	0.20	0.41	0.61	0.82	1.02	1.22	1.43	1.63	1.84	2.04
60	0.24	0.49	0.73	0.98	1.22	1.47	1.71	1.96	2.20	2.45
70	0.29	0.57	0.86	1.14	1.43	1.71	2.00	2.28	2.57	2.86
80	0.33	0.65	0.98	1.31	1.63	1.96	2.28	2.61	2.94	3.26
90	0.37	0.73	1.10	1.47	1.84	2.20	2.57	2.94	3.30	3.67
100	0.41	0.82	1.22	1.63	2.04	2.45	2.86	3.26	3.67	4.08

[A] Calculated using Eq 3 with the coefficient of thermal expansion for CPVC 4120-05 of 3.4×10^{-5}, *in./in.°F*

TABLE 13 Water-Filled Schedule 80 CPVC 4120-05 (23447) Pipe Support Spacing / (ft)

Pipe Size	Support Spacing *l*, ft				
	73°F	100°F	140°F	180°F	200°F
½	4	4	3-¾	3-¾	3-½
¾	4-½	4-½	4-¼	4	4
1	5	5	4-¾	4-½	4-½
1-¼	5-½	5-½	5-¼	5	4-¾
1-½	5-¾	5-¾	5-½	5-¼	5
2	6-½	6-¼	6	5-¾	5-½
3	7-¾	7-½	7-¼	7	6-¾
4	8-½	8-½	8	7-¾	7-½
6	10-¼	10	9-½	9	8-¾
8	11-¼	11	10-½	10-¼	10
10	12-½	12-¼	11-¾	11-¼	11
12	13-¾	13-¼	12-¾	12-¼	11-¾

[A] The industry has not yet agreed to a specific numerical value to use for long term or creep modulus for CPVC 4120-05 in bending. The equation presented is this standard for pipe support spacing is based on more than 35 years of historical design experience. Regardless of modulus used to calculate support spacing, some additional deflection will occur over time.
[B] Support spacing lengths (*l*) are rounded off.

TABLE 14 Water Pressure Ratings at 73°F [23°C] for CPVC 4120-05 Plastic Pipe, Schedule 80[A]

Nominal Pipe Size	Unthreaded		Threaded	
	psi	[kPa]	psi	[kPa]
¼ [8]	1130	[7 790]	570	[3 930]
3/8 [10]	920	[6 340]	460	[3 170]
½ [15]	850	[5 860]	420	[2 900]
¾ [20]	690	[4 760]	340	[2 340]
1 [25]	630	[4 340]	320	[2 210]
1¼ [32]	520	[3 590]	260	[1 790]
1½ [40]	470	[3 240]	240	[1 650]
2 [50]	400	[2 760]	200	[1 380]
2½ [65]	420	[2 900]	210	[1 450]
3 [80]	370	[2 550]	190	[1 310]
3½ [90]	350	[2 410]	170	[1 170]
4 [100]	320	[2 210]	160	[1 100]
5 [125]	290	[2 000]	140	[970]
6 [150]	280	[1 930]	140	[970]
8 [200]	250	[1 720]	120	[830]
10 [250]	230	[1 590]	120	[830]
12 [300]	230	[1 590]	110	[760]

[A] See Table 12, "Allowable Stress", for elevated temperature correction factors.

0.10-in. based on (Eq 6). Support spacing shall be calculated using (Eq 5). Use the modulus of elasticity at the maximum system operating temperature (Table 12) when calculating support spacing.

8. Joints and Connections

8.1 Plastic pipe, tubing, and fittings may be joined by the solvent-cement method, heat-fusion method, threading, elastomeric seals, or by means of other mechanical devices. Consult applicable ASTM practices. The method used shall be compatible with the materials being joined. The recommendations of the manufacturer shall be taken into consideration when determining which method and the details of the procedure to be used.

8.2 *Joint Requirements:*

8.2.1 Solvent-cement joints and heat-fusion joints shall be made in accordance with qualified procedures that have been established and proven by test to produce water-tight joints at least as strong as the pipe or tubing being joined.

8.2.2 Solvent-cement or heat-fusion joints shall not be made between different kinds of plastics.

8.2.3 Heat-fusion or mechanical joints shall be used when joining polyethylene pipe, tubing, or fittings.

8.2.4 Solvent-cement joints may be made between PVC pipe and PVC fittings.

8.2.5 Flanges or special joints may be used, provided that they are properly qualified and utilized by the design engineer or user, or both.

8.3 *Solvent-Cement Joints:*

8.3.1 Square-cut ends free of burrs are required for a proper socket joint.

8.3.2 Proper fit between the pipe or tubing and mating socket or sleeve is essential to a good joint.

8.3.3 The mating surfaces shall be clean, dry, and free of materials that might be detrimental to the joint.

8.3.4 Solvent cements shall conform to Specification D2564 or F545 for making PVC joints.

8.3.5 A uniform coating of the solvent cement is required on both mating surfaces unless otherwise recommended by the manufacturer. Use a primer on PVC pipe. After the joint is made, excess cement shall be wiped from the outside of the joint. This paragraph is not applicable to joints made in accordance with Specification F545.

8.3.6 The joint shall not be disturbed until it has properly set.

8.3.7 A solvent-cement joint shall not be heated to accelerate the setting of the cement.

8.3.8 For more detail on making PVC solvent-cement joints see Practice D2855. For more detail on making joints by injecting solvent cement see Specification F545.

8.4 *Heat Fusion Joints:*

8.4.1 Sound butt heat-fusion joints require the use of a jointing device that holds the heater element square to the machined ends of the piping, compresses the heated ends together, and holds the piping in proper alignment while the plastic hardens.

8.4.2 Sound socket heat-fusion joints require the use of a jointing device that heats the mating surfaces of the joint uniformly and simultaneously to essentially the same temperature. The complete joint shall not be disturbed until properly set.

8.4.3 Use care in the heating operation to prevent damage to the plastic material from overheating or having the material not sufficiently heated to assure a sound joint. Direct application of heat with a torch or other open flame is prohibited.

8.5 *Gasketed Joints:*

8.5.1 Elastomeric gaskets shall conform to Specification F477. Gasket Material shall be compatible with the pipe and fitting plastic. Internal tubular rigid stiffeners may be used in conjunction with the couplings for pipes with thin walls.

8.5.2 *Joint Types:*

8.5.2.1 *Mechanicial Joints*—When elastomeric-sealed mechanical-type joints are used, the joint shall be designed and installed to effectively sustain the longitudinal pull-out forces caused by contraction of the pipe and by external loading.

8.5.2.2 *Push-on Joints*—When push-on joints are used, the joint shall be designed and installed to effectively allow for longitudinal movement caused by expansion and contraction of the pipe and by external loading.

8.5.3 Clean the gasket, the bell groove area (except when the gasket is permanently installed), and the spigot area with rag, brush, or paper towel to remove any dirt or foreign material before making the assembly. Good joints cannot be made with gaskets, pipe spigot bevels, gasket grooves, and sealing surfaces that are damaged or deformed.

8.5.4 Apply lubricant recommended or supplied by the pipe manufacturer.

8.5.5 Good alignment of the pipe is essential for ease of assembly. Align the spigot with the bell and insert the spigot into the bell until it contacts the gasket uniformly. Apply the spigot end of the pipe straight into the bell, that is not cocked, but aligned.

8.5.6 Too much resistance in inserting the pipe into the bell indicates a problem that needs correction. Disassemble the joint and start over.

8.5.7 A square cut end is essential for proper assembly. The pipe can be easily cut with a hacksaw, handsaw, or a power handsaw with a steel blade or abrasive disk. Make a bevel angle recommended by the manufacturer of the pipe.

8.5.8 Take into consideration the recommendations of the pipe manufacturer.

8.6 *Valves in Plastic Piping:*

8.6.1 Valves in plastic piping may be made of any appropriate material and design found suitable by the design engineer and user.

8.6.2 Valve installation in plastic piping shall be designed to protect the plastic material against excessive torsional or shearing loads when the valve or shutoff is operated, and from thrust or any other secondary stresses that might be exerted through the valve or its enclosure.

8.7 *Threaded Joints:*

8.7.1 For all pipe and fittings having taper threads, threads shall conform to Specification F1498.

9. Inspection and Handling

9.1 Carefully inspect pipe and tubing before use for damages, cuts, scratches, gouges, and other imperfections; reject any pipe or tubing containing harmful imperfections. The field inspection provided on each installation should be suitable to minimize the chance that any plastic pipe or tubing containing harmful imperfections will be installed.

9.2 Skillful application of qualified techniques and the use of proper materials and equipment in good condition are required to achieve sound joints in plastic piping by the solvent-cement or heat-fusion methods. Inspection provisions should be adequate to assure that sound joints are being made. Check visually the quality of the joints on a sampling basis and, if there is any reason to believe the joint is defective, remove and replace it.

9.3 Exercise care to avoid rough handling of plastic pipe and tubing. It should not be pushed or pulled over sharp projections, dropped, or have other objects dropped upon it. Take care to prevent kinking or buckling; remove any kinks or buckles that occur by cutting the defect out as a cylinder. Protect the piping components from fire, excessive heat, and harmful chemicals. Adequately support the pipe and tubing during storage. Protect thermoplastic pipe, tubing, and fittings from long-term exposure to direct sunlight unless they are made from materials that are compounded for this purpose.

10. Installation

10.1 Do not install piping above ground unless precautions are taken to provide protection from excessive heat, mechanical damage, fire damage, and from the direct rays of the sun if the piping material used is adversely affected by long-term outside exposure. Install piping in such a way that shear or tensile stresses resulting from construction, backfill, thermal contraction, or external loading are minimized. Install buried piping with a cover not less than 12 in. (300 mm) below the surface or below the maximum expected frost penetration, whichever is greater. A minimum cover of 24 in. (600 mm) is recommended for pipe subjected to heavy traffic loads. When this provision cannot be met, or where external loads may be excessive, the piping shall be encased, bridged, or designed to withstand the anticipated external loads. Where farming or other operations might result in deep plowing, in areas subject to erosion, or in locations where future grading is likely, additional protection shall be provided. There should be at least 6 in. (150 mm) clearance, wherever possible, between buried pipelines and any other underground structures not used in conjunction with the pipe line. Where such clearance cannot be attained, take precautions to protect the pipe, such as by the use of casing, bridging, or insulating material. Install piping so that the temperature of the plastic material will not exceed 27°C (80°F) under normal service conditions unless the system is designed for a higher operating temperature.

11. Alignment and Grade

11.1 Lay and maintain all pipe to the required lines and grades. Fittings, valves, and hydrants shall be at the required locations with joints centered, spigots bottomed, and all valve and hydrant stems plumb. All underground and surface utility structures, drains, sewers, and other structures encountered shall be given temporary support, adequate protection, and maintenance. When the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed, in cooperation with the owners of such utility structures. Whenever it is necessary to determine the location of existing underground utility structures, examine available records and make explorations and excavations as required.

12. Burial

12.1 Bury pipe in accordance with Practice D2774. Lay piping on undisturbed or well-compacted soil. Plastic piping shall not be supported by blocking; use well-tamped earth or other continuous support. Install the piping with provisions for possible contraction when the installation is made under high-temperature conditions. Cooling may be necessary before the last connection is made. When long sections of piping that have been assembled alongside the ditch are lowered in, avoid any strains that may overstress or buckle the piping or impose excessive stress on the joints. Perform backfilling in a manner to provide firm support around the piping. The material used for backfilling shall be free of large rocks, pieces of pavement, or any other materials that might cause damage to the pipe. Where flooding of the trench is done to consolidate the backfill, see that the piping is not floated from its firm bearing on the trench bottom.

12.2 An electrically conductive wire may be installed with the piping to facilitate locating it with an electronic pipe locator. Other suitable material or means for accomplishing this purpose may be employed.

13. Bends and Branches

13.1 Changes in direction of plastic piping may be made with bends, tees, or elbows under the following limitations: Plastic pipe and tubing may be deflected to a radius not less than the minimum recommended by the manufacturer for the kind, type, grade, wall thickness, and diameter of the particular plastic used. The bends shall be free of buckles, cracks, or other evidence of damage. Changes in direction that cannot be made in accordance with the above shall be made with elbow-type fittings. Miter bends are not permitted. Make branch connections only with tees or other suitable fittings specifically designed for the purpose. Provide thrust blocks where changes in direction of the piping or change in line size may produce end thrusts that exceed the pull-out strength of the particular joining devices.

14. Field Repair of Gouges and Grooves

14.1 Remove injurious gouges, grooves, kinks, or buckles by cutting out the damaged portion as a cylinder and replacing it with an undamaged piece of pipe or a coupling.

15. Installation of Plastic Service Line Into or Under Building

15.1 Encase underground plastic service-line installed through the outer foundation or wall of building in a rigid sleeve with suitable protection from shearing action or backfill settlement. The sleeve shall extend past the outside face of the foundation a sufficient distance to reach undisturbed soil or thoroughly compacted backfill. At the point where the sleeve terminates inside the foundation or wall, seal the space between the sleeve and the service line to prevent leakage into the building. Bridge, or encase in a rigid casing, plastic service-line installed underground under a building.

16. Service-Line Connections to Mains

16.1 Service-line connections to mains shall be accomplished with suitable fittings with a compression end or other suitable transition fitting. Design and install a compression type or other mechanical type service line-to-main connection to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or by external loading.

17. Pressure Testing

17.1 The structural integrity of a pipe and its joints shall be demonstrated by a pressure test that is conducted after installation and prior to placement into service. During pressure testing, safety precautions shall be instituted to protect personnel and property in case of pipe or component failure. The precautions taken will depend upon the nature of pipeline materials, design of the system, volumetric content, test pressure, location, and duration. Some important precautions include:

17.1.1 Conduct pressure testing with water, or other environmentally safe incompressible fluid, except for the case of pipelines specifically designed for compressed gas service (for example, natural gas distribution lines), which may be tested with compressed gas.

17.1.2 Pipe shall be adequately anchored to prevent movement. The joints and fittings may remain exposed to facilitate inspection for joint leakage.

17.1.3 Testing shall not begin until sufficient joint cure time has elapsed, concreted thrust blocks have cured and authorized by the engineer or other authority.

17.1.4 The pipeline shall be slowly filled with water taking care to prevent surge and air entrapment. All entrappped air shall be released. If required, the system shall include appropriate air release and air/vacuum relief valves. Air/vacuum valves or vents shall be provided at all high points in the piping system to purge air pockets while the system is filling. Pressure regulators may be necessary at the low points in the system.

17.1.5 The temperature of the test medium shall not be less than 40°F (5°C), nor greater than 90°F (30°C). The pipe and appurtenance manufacturer shall be consulted for recommendations and safeguards when testing outside this temperature range.

17.2 The test pressure and duration shall meet the requirements of the applicable local, state, and federal regulations. In absence of such regulations, the test pressure and duration shall be as directed by the contract documents of the engineer. In the absence of all of the directions for specific recommendations for test pressure and duration, the following procedure may be used.

17.2.1 The line shall be pressurized to 150% of the system's design operating pressure, but not less than 15 psig, nor in excess of the pressure rating for the pipe or appurtenances nor the maxim allowable test pressure of any non-isolated component. Measure the pressure at the lowest elevations possible.

17.2.2 The duration of pressurization shall be maintained for the specified test time while monitoring for pressure loss.

17.2.3 All visible leaks and any leakage in excess of the permitted allowance shall be repaired and the line recharged and retested following the same procedure.

18. Leak Testing

18.1 Any required leakage test shall be conducted as specified. The purpose of a leakage test is to establish that the section of line tested, including all joints, fittings and other appurtenances, will not leak or that leakage is within the limits of the applicable allowance.

19. Disinfecting

19.1 Before placing in service, all plastic pipelines that are intended for the transport of potable water should be disinfected in accordance with C651–AWWA Standard for Disinfecting Water Mains[4].

20. Keywords

20.1 design; disinfecting; field repair; inspection; installation; joints; pressure piping; service line; testing; thermoplastic; water

SUPPLEMENTARY REQUIREMENTS

Supplementary Requirements Potable Water Requirement

This requirement applies whenever a Regulatory Authority or user calls for product to be used to convey or to be in contact with potable water.

S1. *Potable Water Requirement*—Products intended for contact with potable shall be evaluated, tested, and certified for conformance with NSF/ANSI Standard No. 61 or the health effects portion of NSF/ANSI Standard No. 14 by an acceptable certifying organization when required by the regulatory authority having jurisdiction.

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (F645–15) that may impact the use of this standard. (Approved May 15, 2015.)

(1) Added Section 7 CPVC 4120-05 Design Data for Above Ground Installation with Solvent Cemented Joints
(2) Added Section 7.1 CPVC 4120-05 Thermal Expansion
(3) Added Section 7.2 CPVC 4120-05 Expansion Loops and Offset Lengths
(4) Added Section 7.3 CPVC 4120-05 Pipe Support Spacing
(5) Added Table 11 CPVC 4120-05 Thermal Expansion
(6) Added Table 12 Temperature Correction Factors for CPVC 4120-05 (23447) Allowable Stress and Modulus of Elasticity
(7) Added Table 13 Water-Filled CPVC 4120-05 (23447) Pipe Support Spacing
(8) Added Table 14 Water Pressure Ratings at 73°F [23°C] for CPVC 4120-05 Plastic Pipe, schedule 80
(9) Added Section 1.3.2, CPVC Plastic Piping Components

Committee F17 has identified the location of selected changes to this standard since the last issue (F645–13) that may impact the use of this standard. (Approved April 1, 2015.)

(1) Revised 5.4.