Designation: F645 – 15

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

This standard is issued under the fixed designation F645; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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 nonconformance 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 1.3.3 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 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

1.3.3 *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

1.3.4 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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

[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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[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.

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

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

[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

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.

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

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.

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.

devices installed. The surge or water hammer resulting from rapid flow stoppage may be calculated by means of the following equation:

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

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 7.2.1 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 7.2.1 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.

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.

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 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.

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:

$$\Delta L = 12\alpha L(\Delta T) \tag{3}$$

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

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.

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.

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

L_o = Offset and Loop lengths, *in*
E = Modulus of Elasticity at maximum system temperature from Table 9, *lb/in*^{2}
S = Design stress at maximum system temperature from Table 9, *lb/in*^{2}
D_o = Pipe outside diameter, in ΔL
ΔL = Change in length, from Eq 3, 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