FLOWGUARD GOLD®
PIPE & FITTINGS

CORZAN®
PIPING SYSTEMS

DESIGN AND INSTALLATION MANUAL FOR WATER DISTRIBUTION SYSTEMS

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Introduction

FlowGuard Gold® pipe and fittings are made from a specialty plastic known chemically as chlorinated polyvinyl chloride (CPVC). FlowGuard Gold CPVC is the result of new technology that ensures increased product toughness year round. FlowGuard Gold water distribution systems are assembled with readily available, inexpensive tools. Solvent cemented joints - proven with nearly 50 years of successful service history - assure the reliability of a FlowGuard Gold plumbing system.

FlowGuard Gold pipe and fittings are available in copper tube sizes (CTS) from 1/2" to 2". Corzan® CPVC pipe and fittings can be utilized in systems requiring larger size pipe and fittings. Corzan pipe and fittings are available in iron pipe sizes (IPS) from 1/2" to 24" and greater in diameter. Fittings are available for easy transition from the IPS Corzan CPVC to CTS FlowGuard Gold CPVC.

Lubrizol produces and sells CPVC compounds to licensed manufacturers of FlowGuard Gold pipe and fittings and Corzan pipe and fittings *(see back cover for contact information).*

This design manual provides instructions for handling and installing a FlowGuard Gold/Corzan water distribution system as well as information regarding system design. It is intended as a supplement to basic, fundamental knowledge relating to the installation and/or repair of CPVC water distribution systems. It is also intended to supplement installation instructions published by manufacturers of pipe and fittings. Before commencing installation, a user should understand and confirm local code approval and installation requirements for CPVC water distribution systems.

Product Rating, Capabilities and Material Properties

Safety

Extensive studies of CPVC piping demonstrate that no significant health risks are associated with installing CPVC piping, and that risk levels are well below accepted standards, especially when new, low-VOC one-step cement is used.

Lubrizol and the manufacturers of FlowGuard Gold and Corzan CPVC pipe fully endorse safety and protective measures recommended by government agencies when installing FlowGuard Gold or Corzan CPVC pipe, other plastic pipe or metal pipe.

Whenever possible, ensure proper ventilation when applying primers and cements and/or soldering materials.

Avoid unnecessary skin or eye contact with primers and cements and/or soldering materials. Wash immediately if contact occurs to avoid prolonged exposure.

Follow all manufacturer-recommended precautions when cutting or sawing pipe or when using any flame, heat or power tools.

After testing, thoroughly flush the system for at least 10 minutes to remove residual trace amounts of solvent cement or flux/solder components.

Product Standards and Listings

FlowGuard Gold pipe and fittings are produced to the requirements of ASTM D2846. Corzan pipe is produced to the requirements of ASTM F441. Corzan fittings are produced to the requirements of ASTM F437 (schedule 80 threaded), and ASTM F439 (schedule 80 socket). CPVC solvent cement is produced to the requirements of ASTM F493.

FlowGuard Gold and Corzan pipe, fittings and solvent cements are certified by NSF International for use with potable water (NSF-pw). The NSF certification is applicable for all water pH levels.

(Table 1)

CPVC Related Standards

Standard	Title
ANSI/NSF Standard 14	Plastic Piping Components and Related Materials
ANSI/NSF Standard 61	Drinking Water System Components - Health Effects
ASTM D2846	Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
ASTM F402	Standard Practice for Safe Handling of Solvent Cements, Primers and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Specification for Threaded Chlorinated Poly(Vinyl Chloride)(CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F439	Specification for Socket-Type Chlorinated Poly(Vinyl Chloride)(CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedule 40 and 80
ASTM F493	Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) CPVC Plastic Pipe and Fittings
ASTM F656	Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride)(PVC) Plastic Pipe and Fittings
CSA B137.6	CPVC Pipe, Tubing, and Fittings for Hot and Cold Water Distribution Systems
CSA B137.16	Recommended Practice for the Installation of CPVC Piping for Hot and Cold Water Distribution Systems

Pressure Rating

FlowGuard Gold Systems. FlowGuard Gold Systems (1/2" through 2" CTS), including the joint, are rated for a continuous working pressure of 100 psi at 180°F (400 psi at 73°F).

Corzan Systems. Schedule 80 Corzan pipe and fittings are available from 1/2" to 24" IPS and greater in diameter. The pressure rating and temperature derating factor for Corzan pipe is found in Tables 2 and 3:

The long term performance of FlowGuard Gold and Corzan pipe under continuous pressure is tested in accordance with ASTM D1598. Test data is evaluated in accordance with ASTM D2837 and the final pressure rating (as stenciled on the pipe) is determined incorporating a safety factor of 2. Because of this safety factor of 2, engineers and plumbing designers can be assured that they can safely design their piping systems using FlowGuard Gold and Corzan piping systems up to the full pressure designation that is stenciled on the pipe.

(Table 2)

Pipe Size vs. Pressure Rating

Nominal Pipe Size (in)	Maximum Water Pressure (psi) @ 73°F
1/2	850
3/4	690
1	630
1¼	520
1½	470
2	400
2½	420
3	370
4	320
6	280
8	250
10	230
12	230
14	220
16	220
24	210

For temperatures greater than 73°F, see derating factor below.

(Table 3)

Temperature Derating Factors for Corzan Pipe

Working Temperature (°F)	Pipe Derating Factor
73-80	1.00
90	0.91
100	0.82
120	0.65
140	0.50
160	0.40
180	0.25
200	0.20

Pressure Rating at Temperature X = Pressure Rating at 73°F multiplied by Derating Factor at Temperature X

Pipe Dimensions and Weights

FlowGuard Gold pipe is produced (1/2" through 2") in SDR 11 dimensions with CTS (copper tube size) outside diameters. SDR, or Standard Dimension Ratio, means the wall thickness is directly proportional to the outside diameter. This results in all diameters carrying the same pressure rating of 100 psi at 180˚F.

(Table 4)

FlowGuard Gold Pipe Dimensions & Weights SDR 11 (ASTM D2846)

Nominal Pipe Size (in)	Average OD Inches	Average ID Inches	Pounds per Ft. Empty	Pounds per Ft. Water Filled
1/2	0.625	0.489	0.084	0.163
3/4	0.875	0.715	0.141	0.311
1	1.125	0.921	0.232	0.513
1¼	1.375	1.125	0.347	0.767
1½	1.625	1.329	0.486	1.071
2	2.125	1.739	0.829	1.831

Corzan pipe is produced in a schedule system with IPS (iron pipe size) outside diameters. This results in the pressure capability varying with the size of the pipe (see Table 2).

(Table 5)

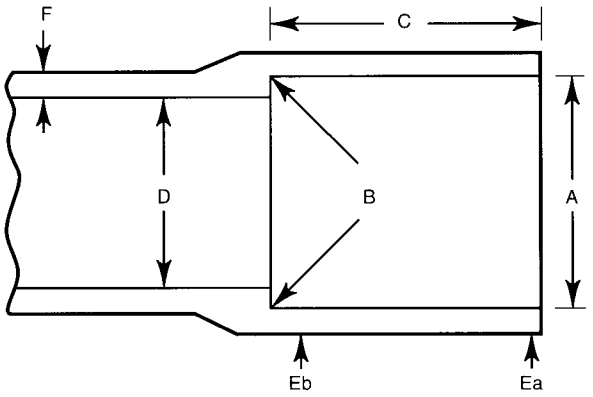
Corzan Pipe Dimensions & Weights Schedule 80 (ASTM F441)

Nominal Pipe Size (in)	Average OD Inches	Average ID Inches	Pounds per Ft. Empty	Pounds per Ft. Water Filled
1/2	0.840	0.528	0.225	0.320
3/4	1.050	0.724	0.305	0.483
1	1.315	0.935	0.450	0.747
1¼	1.660	1.256	0.621	1.157
1½	1.900	1.476	0.754	1.495
2	2.375	1.913	1.043	2.287
2½	2.875	2.289	1.594	3.375
3	3.500	2.864	2.132	4.920
4	4.500	3.786	3.116	7.988
6	6.625	5.709	5.951	17.029
8	8.625	7.565	9.040	28.492
10	10.750	9.492	13.413	44.038
12	12.750	11.294	18.440	61.796
14	14.000	12.410	22.119	74.467
16	16.000	14.214	28.424	97.098

Fitting Dimensions

Figure 1

Tapered Socket Dimensions for FlowGuard Gold, SDR 11, CPVC Tubing Fittings* per ASTM D2846



Nominal Pipe Size (in)	Socket Entrance (A) I.D. Tolerance	Socket Bottom (B) I.D. Tolerance	(C) Min.	(D) Min.	(Ea) Min.	(Eb) Min.	(F) Min.
1/2	0.633 ±0.003	0.619 ±0.003	0.500	0.489	0.068	0.102	0.128
3/4	0.884 ±0.003	0.870 ±0.003	0.700	0.715	0.080	0.102	0.128
1	1.135 ±0.003	1.121 ±0.003	0.900	0.921	0.102	0.102	0.128
1¼	1.386 ±0.003	1.372 ±0.003	1.100	1.125	0.125	0.125	0.156
1½	1.640 ±0.004	1.622 ±0.004	1.300	1.329	0.148	0.148	0.185
2	2.141 ±0.004	2.123 ±0.004	1.700	1.739	0.193	0.193	0.241

**All dimensions are in inches*

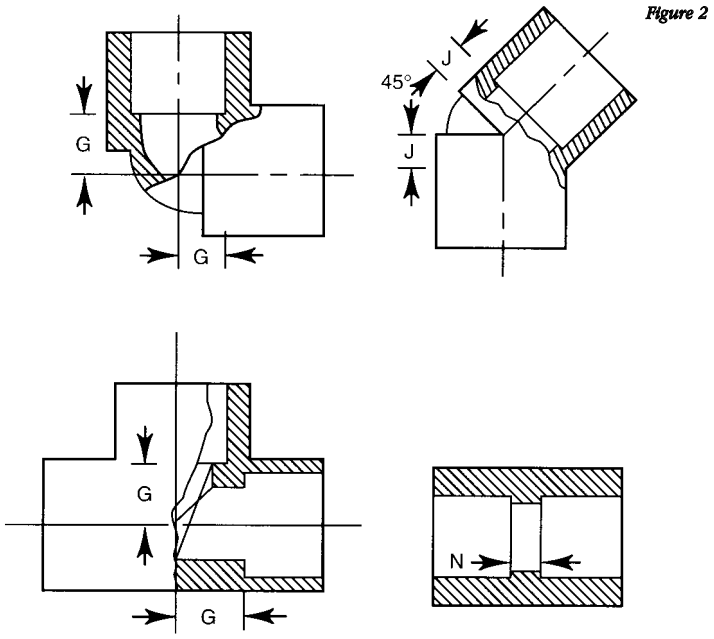


Figure 2

Minimum Dimensions from Center to End of Socket (Laying Length) for FlowGuard Gold, SDR 11 CPVC Tubing Fitting* per ASTM D2846

Nominal Pipe Size (in)	(G) Min.	(J) Min.	(N) Min.
1/2	0.382	0.183	0.102
3/4	0.507	0.235	0.102
1	0.633	0.287	0.102
1¼	0.758	0.339	0.102
1½	0.884	0.391	0.102
2	1.134	0.495	0.102

**All dimensions are in inches*

Typical Physical and Thermal Properties of FlowGuard Gold CPVC and Corzan CPVC

(Table 6)

Physical Properties Comparison

Property	CPVC	ASTM
Specific Gravity	1.55	D792
IZOD Impact Strength (ft. lbs./inch, notched)	10	D256A
Modulus of Elasticity, @ 73°F, psi	4.23×10^5	D638
Ultimate Tensile Strength, psi	8,400	D638
Compressive Strength, psi	9,600	D695
Poisson's Ratio	.35 - .38	-
Working Stress @ 73°F, psi	2,000	D1598
Hazen-Williams C Factor	150	-
Coefficient of Linear Expansion in./(in. °F)	3.8×10^{-5}	D696
Thermal Conductivity BTU/hr./ft.^{2}/°F/in.	0.95	C177
Limiting Oxygen Index	60%	D2863
Electrical Conductivity	Non Conductor	

Hydraulic Design

Sizing CPVC Pipe. A FlowGuard Gold system will use the same size pipe that a copper system would for a typical residential installation. For systems using larger sizes, design should be based on fixture demand rates. A FlowGuard Gold system, unlike systems utilizing insert fittings for joining the pipe, offers full-bore flow. This results in significantly reduced head loss.

Design Velocity. The process for establishing a limiting or maximum flow velocity that is applicable to any piping material is not well defined. For some materials, there may be velocities that can create abrasion or erosion, but there is no evidence that this occurs with CPVC piping under any known operating conditions. An investigation of some CPVC systems revealed that velocities of 7 to 17 feet per second could be developed under maximum flow conditions.

A maximum design velocity of 10 feet per second is typically utilized for both hot water and cold water CTS CPVC systems (1/2" through 2") and for IPS CPVC hot and cold water distribution systems 4" and smaller. A design velocity of 5 feet per second is typically used for IPS CPVC water distribution systems larger than 4". This design velocity is based on both field experience and laboratory investigation. The CPVC design velocity is different from copper, which has a recommended maximum design velocity of 5 feet per second for hot water and 8 feet per second for cold water.

The system should be designed and installed utilizing good engineering practices. To avoid water hammer, quick closing valves are not recommended on 2" to 4" IPS water mains when the velocity exceeds 5 ft/sec. It is acceptable to have quick closing valves on the smaller branch lines.

Hazen-Williams C Factor. Hydraulic calculations for sizing of FlowGuard Gold pipe and fittings should be calculated using a Hazen-Williams C Factor of 150. While both copper and CPVC use a C Factor of 150 for new systems, as copper ages, the ID of the pipe is subject to pitting and scaling causing pressure loss to increase over

time. Since a FlowGuard Gold system is not subject to pitting or scaling, the C Factor will remain constant as the system ages.

Head-Loss Characteristics - Pipe. The flow characteristics of water flowing through piping systems are affected by several factors including system configuration, pipe size and length, friction at the pipe and fitting surfaces, etc. These and other factors cause a reduction in pressure (head-loss, also expressed as pressure drop) over the length of the system. This section deals only with the head-losses that result from frictional forces in the various sizes of CPVC pipe and fittings.

The following formulas were used to calculate water velocities, head-losses and pressure drops as function of flow rates. The results are given in Tables 7 thru 12. Head-loss as a function of water velocity has also been calculated and can be found in Tables 13 thru 18.

The Hazen-Williams formula can be used to adequately describe these losses:

Head Loss Formula

$$H_L = 0.2083(100/C)^{1.852} \times F_R^{1.852}/d_I^{4.8655}$$

Velocity Formula

$$V_W = 0.4085F_R/d_I^2$$

Where: H_L = Frictional head loss (feet of water per 100 feet)
C = Hazen-Williams factor (150 for CPVC)
F_R = Flow rate (gal/min.)
d_I = Inside diameter of pipe (inches)
V_W = Velocity of water (feet/second)
One foot of water = 0.4335 psi

(Table 7)

FlowGuard Gold Pipe
SDR 11 (ASTM D2846)
Frictional Losses At Different Flow Rates

Flow Rate GPM	1/2"			3/4"			1"		
	V_W	H_L	P_L	V_W	H_L	P_L	V_W	H_L	P_L
1	1.71	3.19	1.38	0.80	0.50	0.22	0.48	0.15	0.06
2	3.42	11.53	5.00	1.60	1.82	0.79	0.96	0.53	0.23
3	5.13	24.43	10.59	2.40	3.85	1.67	1.44	1.12	0.49
4	6.83	41.62	18.04	3.20	6.55	2.84	1.93	1.91	0.83
5	8.54	62.91	27.27	4.00	9.91	4.29	2.41	2.89	1.25
6	10.25	88.18	38.23	4.79	13.89	6.02	2.89	4.05	1.76
7	11.96	117.32	50.86	5.59	18.47	8.01	3.37	5.39	2.34
8	13.67	150.23	65.13	6.39	23.66	10.26	3.85	6.90	2.99
9	15.38	186.85	81.00	7.19	29.42	12.76	4.33	8.58	3.72
10	17.08	227.11	98.45	7.99	35.76	15.50	4.82	10.43	4.52
15				11.99	75.78	32.85	7.22	22.11	9.58
20				15.98	129.11	55.97	9.63	37.67	16.33
25							12.04	56.94	24.69
30							14.45	79.82	34.60
35							16.86	106.19	46.03

(Table 8)

FlowGuard Gold Pipe
SDR 11 (ASTM D2846)
Frictional Losses At Different Flow Rates

Flow Rate GPM	1¼"			1½"			2"		
	V_W	H_L	P_L	V_W	H_L	P_L	V_W	H_L	P_L
5	1.61	1.09	0.47	1.16	0.49	0.21	0.68	0.13	0.06
10	3.23	3.94	1.71	2.31	1.75	0.76	1.35	0.49	0.21
15	4.84	8.35	3.62	3.47	3.71	1.61	2.03	1.03	0.45
20	6.46	14.23	6.17	4.63	6.33	2.74	2.70	1.76	0.76
25	8.07	21.51	9.33	5.78	9.56	4.15	3.38	2.66	1.15
30	9.68	30.15	13.07	6.94	13.40	5.81	4.05	3.73	1.62
35	11.30	40.11	17.39	8.09	17.83	7.73	4.73	4.96	2.15
40	12.91	51.37	22.27	9.25	22.83	9.90	5.40	6.35	2.75
45	14.52	63.89	27.70	10.41	28.40	12.31	6.08	7.89	3.42
50	16.14	77.66	33.66	11.56	34.52	14.96	6.75	9.60	4.16
55	17.75	92.65	40.16	12.72	41.18	17.85	7.43	11.45	4.96
60				13.88	48.38	20.97	8.10	13.45	5.83
70				16.19	64.37	27.90	9.46	17.89	7.76
80							10.81	22.91	9.93
90							12.16	28.50	12.35
100							13.51	34.64	15.02
125							16.89	52.37	22.70

(Table 9)

Corzan Pipe
Schedule 80 (ASTM F441)
Frictional Losses At Different Flow Rates

Flow Rate GPM	1/2"			3/4"			1"		
	V_W	H_L	P_L	V_W	H_L	P_L	V_W	H_L	P_L
1	1.47	2.20	0.95	0.78	0.47	0.21			
3	4.40	16.82	7.29	2.34	3.62	1.57	1.40	1.04	0.45
5	7.33	43.31	18.78	3.90	9.32	4.04	2.34	2.69	1.16
7	10.26	80.76	35.01	5.46	17.38	7.54	3.27	5.01	2.17
10				7.81	33.65	14.59	4.68	9.70	4.20
15				11.71	71.31	30.91	7.02	20.55	8.91
20							9.35	35.00	15.17
25							11.69	52.91	22.94
30							14.03	74.17	32.15

V_W = Velocity of water (feet/second)
H_L = Frictional head loss (feet of water per 100 feet)
P_L = Pressure Loss (psi per 100 feet)

(Table 10)

Corzan Pipe Schedule 80 (ASTM F441) Frictional Losses At Different Flow Rates

Flow Rate GPM	1¼"			1½"			2"		
	V_W	H_L	P_L	V_W	H_L	P_L	V_W	H_L	P_L
3	0.78	0.25	0.11	0.56	0.11	0.05			
5	1.30	0.64	0.28	0.94	0.29	0.13	0.56	0.08	0.04
7	1.81	1.19	0.52	1.31	0.54	0.24	0.78	0.15	0.07
10	2.59	2.31	1.00	1.88	1.05	0.46	1.12	0.30	0.13
15	3.89	4.89	2.12	2.81	2.23	0.97	1.68	0.63	0.27
20	5.18	8.33	3.61	3.75	3.80	1.65	2.23	1.08	0.47
25	6.48	12.59	5.46	4.69	5.74	2.49	2.79	1.63	0.70
30	7.78	17.64	7.65	5.63	8.05	3.49	3.35	2.28	0.99
35	9.07	23.47	10.18	6.57	10.70	4.64	3.91	3.03	1.31
40	10.37	30.06	13.03	7.51	13.71	5.94	4.47	3.88	1.68
45	11.66	37.38	16.21	8.44	17.05	7.39	5.03	4.83	2.09
50	12.96	45.44	19.70	9.38	20.72	8.98	5.58	5.87	2.54
60				11.26	29.04	12.59	6.70	8.22	3.57
70				13.13	38.64	16.75	7.82	10.94	4.74
80							8.93	14.01	6.07
90							10.05	17.42	7.55
100							11.17	21.18	9.18
125							13.96	32.02	13.88

(Table 11)

Corzan Pipe Schedule 80 (ASTM F441) Frictional Losses At Different Flow Rates

Flow Rate GPM	2½"			3"			4"		
	V_W	H_L	P_L	V_W	H_L	P_L	V_W	H_L	P_L
25	1.95	0.68	0.29	1.25	0.23	0.10	0.71	0.06	0.03
50	3.90	2.45	1.06	2.49	0.82	0.36	1.42	0.21	0.09
75	5.85	5.19	2.25	3.74	1.74	0.76	2.14	0.45	0.19
100	7.80	8.85	3.83	4.98	2.97	1.29	2.85	0.76	0.33
125	9.75	13.37	5.80	6.23	4.49	1.95	3.56	1.16	0.50
150	11.69	18.74	8.12	7.47	6.30	2.73	4.27	1.62	0.70
175	13.64	24.94	10.81	8.72	8.38	3.63	4.99	2.16	0.93
200	15.59	31.93	13.84	9.96	10.73	4.65	5.70	2.76	1.20
225	17.54	39.71	17.22	11.21	13.35	5.79	6.41	3.43	1.49
250				12.45	16.22	7.03	7.12	4.17	1.81
300				14.94	22.74	9.86	8.55	5.85	2.54
350				17.43	30.25	13.12	9.97	7.78	3.37
400							11.40	9.96	4.32
500							14.25	15.06	6.53
600							17.10	21.11	9.15

V_W = Velocity of water (feet/second)
H_L = Frictional head loss (feet of water per 100 feet)
P_L = Pressure Loss (psi per 100 feet)

(Table 12)

Corzan Pipe Schedule 80 (ASTM F441) Frictional Losses At Different Flow Rates

Flow Rate GPM	6"			8"			10"		
	Vw	H_L	P_L	Vw	H_L	P_L	Vw	H_L	P_L
100	1.25	0.10	0.04	0.71	0.03	0.01	0.45	0.01	0.00
200	2.51	0.37	0.16	1.43	0.10	0.04	0.91	0.03	0.01
300	3.76	0.79	0.34	2.14	0.20	0.09	1.36	0.07	0.03
400	5.01	1.35	0.59	2.86	0.34	0.15	1.81	0.11	0.05
500	6.27	2.04	0.89	3.57	0.52	0.23	2.27	0.17	0.07
600	7.52	2.86	1.24	4.28	0.73	0.32	2.72	0.24	0.10
700	8.77	3.81	1.65	5.00	0.97	0.42	3.17	0.32	0.14
800	10.03	4.88	2.11	5.71	1.24	0.54	3.63	0.41	0.18
900	11.28	6.06	2.63	6.42	1.54	0.67	4.08	0.51	0.22
1000	12.53	7.37	3.20	7.14	1.87	0.81	4.53	0.62	0.27
1250	15.67	11.14	4.83	8.92	2.83	1.23	5.67	0.94	0.41
1500				10.71	3.97	1.72	6.80	1.32	0.57
1750				12.49	5.28	2.29	7.93	1.75	0.76
2000				14.28	6.76	2.93	9.07	2.24	0.97
2250				16.06	8.41	3.65	10.20	2.79	1.21
2500							11.33	3.39	1.47
3000							13.60	4.75	2.06
3500							15.87	6.32	2.74

(Table 13)

FlowGuard Gold Pipe SDR 11 (ASTM D2846) Frictional Losses At Different Water Velocities

	1/2"			3/4"			1"		
V_W	F_R	H_L	P_L	F_R	H_L	P_L	F_R	H_L	P_L
2	1.17	4.28	1.85	2.50	2.75	1.19	4.15	2.05	0.89
4	2.34	15.44	6.69	5.01	9.93	4.30	8.31	7.40	3.21
6	3.51	32.71	14.18	7.51	21.04	9.12	12.46	15.68	6.80
8	4.68	55.72	24.16	10.01	35.84	15.54	16.61	26.71	11.58
10	5.85	84.24	36.52	12.51	54.18	23.49	20.76	40.38	17.50

(Table 14)

FlowGuard Gold Pipe SDR 11 (ASTM D2846) Frictional Losses At Different Water Velocities

	1¼"			1½"			2"		
V_W	F_R	H_L	P_L	F_R	H_L	P_L	F_R	H_L	P_L
2	6.2	1.62	0.70	8.6	1.34	0.58	14.8	0.98	0.42
4	12.4	5.86	2.54	17.3	4.83	2.09	29.6	3.54	1.53
6	18.6	12.43	5.39	25.9	10.24	4.44	44.4	7.49	3.25
8	24.8	21.17	9.18	34.6	17.45	7.56	59.2	12.77	5.53
10	31.0	32.01	13.87	43.2	26.37	11.43	74.0	19.30	8.37

V_W = Velocity of water (feet/second)
F_R = Flow Rate (gal/min.)
H_L = Frictional head loss (feet of water per 100 feet)
P_L = Pressure Loss (psi per 100 feet)

(Table 15)

Corzan Pipe Schedule 80 (ASTM F441) Frictional Losses At Different Water Velocities

	1/2"			3/4"			1"		
V_W	F_R	H_L	P_L	F_R	H_L	P_L	F_R	H_L	P_L
2	1.37	3.91	1.70	2.56	2.70	1.17	4.28	2.01	0.87
4	2.73	14.12	6.12	5.12	9.75	4.23	8.55	7.26	3.15
6	4.10	29.93	12.98	7.68	20.67	8.96	12.83	15.38	6.67
8	5.46	50.99	22.11	10.24	35.22	15.27	17.11	26.20	11.36
10	6.83	77.09	33.42	12.81	53.25	23.09	21.38	39.61	17.17

(Table 16)

Corzan Pipe Schedule 80 (ASTM F441) Frictional Losses At Different Water Velocities

	1¼"			1½"			2"		
V_W	F_R	H_L	P_L	F_R	H_L	P_L	F_R	H_L	P_L
2	7.72	1.43	0.62	10.66	1.18	0.51	17.09	0.88	0.38
4	15.43	5.15	2.23	21.32	4.27	1.85	34.19	3.16	1.37
6	23.15	10.92	4.73	31.98	9.06	3.93	51.28	6.70	2.91
8	30.86	18.60	8.06	42.64	15.43	6.69	68.38	11.42	4.95
10	38.58	28.12	12.19	53.31	23.33	10.11	85.47	17.27	7.48

(Table 17)

Corzan Pipe Schedule 80 (ASTM F441) Frictional Losses At Different Water Velocities

	2½"			3"			4"		
V_W	F_R	H_L	P_L	F_R	H_L	P_L	F_R	H_L	P_L
2	26	0.71	0.31	40	0.55	0.24	70	0.40	0.17
4	51	2.57	1.11	80	1.98	0.86	140	1.43	0.62
6	77	5.45	2.36	120	4.20	1.82	211	3.04	1.32
8	103	9.28	4.02	161	7.15	3.10	281	5.17	2.24
10	128	14.03	6.08	201	10.81	4.69	351	7.82	3.39

(Table 18)

Corzan Pipe Schedule 80 (ASTM F441) Frictional Losses At Different Water Velocities

	6"			8"			10"		
V_W	F_R	H_L	P_L	F_R	H_L	P_L	F_R	H_L	P_L
2	160	0.25	0.11	280	0.18	0.08	441	0.14	0.06
4	319	0.89	0.39	560	0.64	0.28	882	0.49	0.21
6	479	1.88	0.82	841	1.36	0.59	1323	1.04	0.45
8	638	3.21	1.39	1121	2.31	1.00	1764	1.78	0.77
10	798	4.85	2.10	1401	3.50	1.52	2206	2.69	1.17

V_W = Velocity of water (feet/second)
F_R = Flow Rate (gal/min.)
H_L = Frictional head loss (feet of water per 100 feet)
P_L = Pressure Loss (psi per 100 feet)

Head Loss Characteristics - Valves and Fittings. In addition to head losses that result from frictional forces in the pipe, losses also occur when water flows through valves, fittings, etc. in the system. These losses are difficult to calculate due to the complex internal configuration of the various fittings. Generally, loss values are determined for each fitting configuration by experimental tests and are expressed in equivalent length of straight pipe. Typical equivalent length values for valves and fittings can be found in Tables 19 and 20.

(Table 19)

Friction Loss in FlowGuard Gold CTS Valves and Fittings in Terms of Equivalent Length (L) – Feet of Straight Pipe

Nominal Pipe Size (in)	Gate Valve Full Open	Globe Valve Full Open	Angle Valve Full Open	Swing Check Valve Full Open	90° Elbow	Long Radius 90°or 45° Standard Elbow	Standard Tee Through Flow	Standard Tee Branch Flow
1/2	0.41	17.6	7.78	5.18	1.55	0.83	1.04	3.11
3/4	0.55	23.3	10.3	6.86	2.06	1.10	1.37	4.12
1	0.70	29.7	13.1	8.74	2.62	1.40	1.75	5.25
1¼	0.92	39.1	17.3	11.5	3.45	1.84	2.30	6.90
1½	1.07	45.6	20.1	13.4	4.03	2.15	2.68	8.05
2	1.38	58.6	25.8	17.2	5.17	2.76	3.45	10.30

(Table 20)

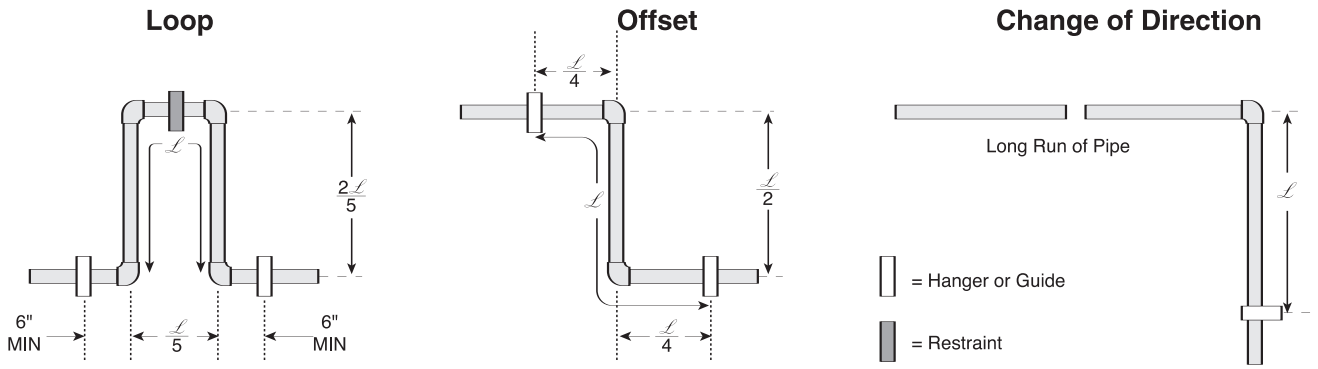
*Friction Loss in Corzan IPS Valves and Fittings in Terms of Equivalent Length (L) – Feet of Straight Pipe**

Nominal Size (in)	90° Standard Elbow	45° Standard Elbow	Standard Tee Run Flow	Standard Tee Branch Flow
1/2	1.5	0.8	1.0	4.0
3/4	2.0	1.1	1.4	5.0
1	2.6	1.4	1.7	6.0
1¼	3.8	1.8	2.3	7.0
1½	4.0	2.1	2.7	8.1
2	5.7	2.7	4.3	12.0
2½	6.9	3.3	5.1	14.7
3	7.9	4.1	6.2	16.3
4	11.4	5.3	8.3	22.0
6	16.7	8.0	12.5	32.2
8	21.0	10.6	16.5	39.7
10	25.1	13.4	19.1	50.1
12	29.8	15.9	22.4	63.0

**The data provided in this table is for reference only. Consult the fitting manufacturer's literature for additional information.*

Figure 3

Expansion Loop and Offset Configuration



Do not butt-up against fixed structure (joist, stud or wall)

Thermal Expansion and Contraction

Like all piping material, FlowGuard Gold CPVC and Corzan CPVC expand when heated and contract when cooled. CPVC piping (regardless of pipe diameter) will expand about 1 inch per 50 feet of length when subjected to a 50°F temperature increase. Therefore, allowances must be made for this resulting movement. However, laboratory testing and installation experience have demonstrated that the practical issues are much smaller than the coefficient of thermal expansion would suggest. The stresses developed in CPVC pipe are generally much smaller than those developed in metal pipe for equal temperature changes because of the difference in elastic modulus. Required loops are smaller than those recommended by the Copper Development Association for copper systems. In vertical piping, loops are not required when the temperature change is 120°F or less. Support of vertical piping should be made per the recommendations in this manual. Refer to the Hangers and Supports section for information on proper supporting of vertical piping.

Expansion is mainly a concern in hot water lines. Generally, thermal expansion can be accommodated with changes in direction; however, a long straight run may require an offset or loop. Only one expansion loop, properly sized, is required in any single straight run, regardless of its total length. If more convenient, two or more smaller expansion loops, properly sized, can be utilized in a single run of pipe to accommodate the thermal movement. For above ground installations, be sure to hang pipe with smooth straps that will not restrict movement. For underslab or below ground installations, be sure backfill material will not restrict movement at the expansion loop, offset or change of direction. For convenience, loop (or offset) lengths have been calculated for different pipe sizes and different run lengths with a temperature increase (ΔT) of about 80°F. The results, shown in Tables 22 and 23, are presented simply as a handy guide for quick and easy determinations of acceptable loop lengths for the approximate conditions. Loop length for other temperatures and run lengths can be calculated utilizing the following equations:

Expansion Loop Formula

$$\mathscr{L} = \sqrt{\frac{3\ ED\ (\Delta L)}{2S}}$$

Where: $\mathscr{L}$ = Loop length (in.)
E = Modulus of elasticity at maximum temperature (psi) (Table 21)
S = Working Stress at maximum temperature (psi) (Table 21)
D = Outside diameter of pipe (in.) (Tables 4 and 5)
ΔL= Change in length due to change in temperature (in.) (see formula below)

Thermal Expansion Formula

$$\Delta L = L_p C\ \Delta T$$

Where: ΔL = Change in length due to change in temperature (in.)
L_p = Length of pipe (in.)
C = Coefficient of thermal expansion (in./in.°F)
= 3.8×10^{-5} in./(in.°F) for CPVC
ΔT = Change in temperature (°F)

(Table 21)

Modulus of Elasticity and Working Stress for CPVC

Temperature (°F)	Modulus, E (psi)	Stress, S (psi)
73	423,000	2000
90	403,000	1800
110	371,000	1500
120	355,000	1300
140	323,000	1000
160	291,000	750
180	269,000	500

(Table 22)

FlowGuard Gold Pipe SDR 11 (ASTM D2846)
Calculated Loop (Offset) Lengths with ΔT of approx. 80°F

Nominal Pipe Size (in)	Length of Run in Feet				
	40	60	80	100	120
	Loop Length (L) in Inches				
1/2	23	28	33	36	40
3/4	27	33	39	43	47
1	31	38	44	49	54
1¼	34	42	48	54	59
1½	37	45	53	59	64
2	42	52	60	67	74

(Table 23)

Corzan Pipe Schedule 80 (ASTM F441)
Calculated Loop (Offset) Lengths with ΔT of approx. 80°F

Nominal Pipe Size (in)	Length of Run in Feet				
	40	60	80	100	120
	Loop Length (L) in Inches				
1/2	27	33	38	42	46
3/4	30	37	42	47	52
1	33	41	47	53	58
1¼	38	46	53	59	65
1½	40	49	57	64	70
2	45	55	64	71	78
2½	49	61	70	78	86
3	55	67	77	86	94
4	62	76	87	98	107
6	75	92	106	119	130
8	86	105	121	135	148
10	96	117	135	151	165
12	104	127	147	165	180

Pipe Deflection

FlowGuard Gold pipe and Corzan pipe are inherently ductile, allowing them to be deflected around or away from objects during installation, which can reduce installation time. This ductility allows for greater freedom of design and lower installed cost. The maximum installed deflections for FlowGuard Gold piping are found in Tables 24 and 25:

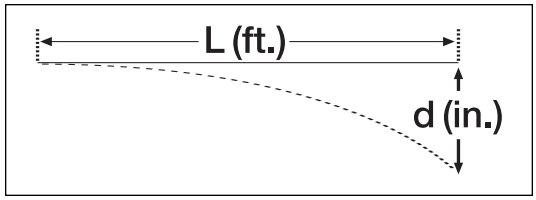
(Table 24)

FlowGuard Gold Pipe, Length in Feet,
SDR 11 (ASTM D2846)

Nominal Pipe Size (in)	2	5	7	10	12	15	17	20	25	30	35	40	45	50
	Permissible Bending Deflections (73°F) in inches - One End Restrained													
1/2	2.1	13.2	25.8	52.6	75.8	118.4	152.1	210.6	329.0	473.8	644.8			
3/4	1.5	9.4	18.4	37.6	54.1	84.6	108.7	150.4	235.0	338.4	460.6	601.6		
1	1.2	7.3	14.3	29.2	42.1	65.8	84.5	117.0	182.8	263.2	358.2	467.9	592.2	
1¼	1.0	6.0	11.7	23.9	34.5	53.8	69.1	95.7	149.5	215.3	293.1	382.8	484.5	598.2
1½	0.8	5.1	9.9	20.2	29.2	45.6	58.5	81.0	126.5	182.2	248.0	323.9	410.0	506.2
2	0.6	3.9	7.6	15.5	22.3	34.8	44.7	61.9	96.8	139.3	189.7	247.7	313.5	387.1

Figure 4

Maximum Installed Deflections
(One End Restrained)



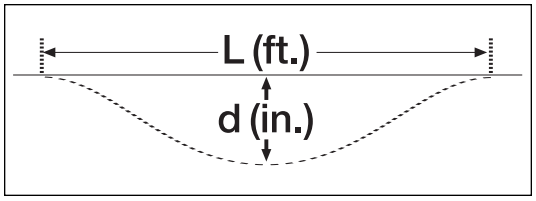
(Table 25)

FlowGuard Gold Pipe, Length in Feet, SDR 11 (ASTM D2846)

Nominal Pipe Size (in)	2	5	7	10	12	15	17	20	25	30	35	40	45	50
	Permissible Bending Deflections (73°F) in inches - Both Ends Restrained													
1/2	0.5	3.3	6.4	13.2	19.0	29.6	38.0	52.7	82.3	118.5	161.2	210.6	266.6	329.1
3/4	0.4	2.4	4.6	9.4	13.5	21.2	27.2	37.6	58.8	84.6	115.2	150.4	190.4	235.1
1	0.3	1.8	3.6	7.3	10.5	16.5	21.1	29.3	45.7	65.8	89.6	117.0	148.1	182.8
1¼	0.2	1.5	2.9	6.0	8.6	13.5	17.3	23.9	37.4	53.8	73.3	95.7	121.2	149.6
1½	0.2	1.3	2.5	5.1	7.3	11.4	14.6	20.3	31.6	45.6	62.0	81.0	102.5	126.6
2	0.2	1.0	1.9	3.9	5.6	8.7	11.2	15.5	24.2	34.8	47.4	61.9	78.4	96.8

Figure 5

Maximum Installed Deflections (Both Ends Restrained)



Handling and Storage

FlowGuard Gold CPVC is a tough, corrosion resistant material, but it does not have the mechanical strength of metal. Reasonable care should be exercised in handling pipe and fittings. They should not be dropped, stepped on, or have objects thrown on them. If improper handling or heavy impact results in cracks, splits, or gouges, cut off at least 2" beyond the visible damage and discard. FlowGuard Gold piping should be covered with a non-transparent material when stored outside for long periods of time. Normal short term exposure to sunlight on the job site will not affect the physical properties or ultimate performance. When installing FlowGuard Gold pipe and fittings in an area that is exposed to direct sunlight for an extended period of time, protect the pipe with compatible insulation, a water-based latex paint or stucco.

Joining FlowGuard Gold Pipe & Fittings

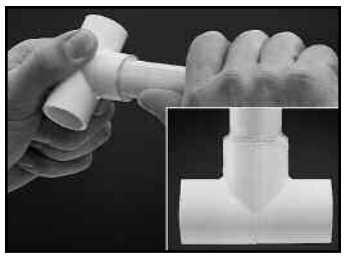
1. Cutting. FlowGuard Gold pipe can be easily cut with a wheel type plastic tubing cutter, ratchet cutter or fine tooth saw. Ratchet cutters should be sharpened regularly. When saw cutting, a miter box should be used to ensure a square cut. Cutting tubing as squarely as possible provides optimal bonding area within a joint. If any indication of damage or cracking is evident at the tubing end, cut off at least 2" beyond any visible crack.

2. Deburring/Beveling. Burrs and filings can prevent proper contact between tube and fitting during assembly, and should be removed from the outside and inside of the tubing. A chamfering tool is preferred but a pocketknife or file are suitable for this purpose. A slight bevel on the end of the tubing will ease entry of the tubing into the fitting socket and minimize the chances of pushing solvent cement to the bottom of the joint.

3. Fitting Preparation. Using a clean and dry rag, wipe dirt and moisture from the fitting sockets and tubing end. Check the dry fit of the tubing and fitting. The tubing should make contact with the socket wall 1/3 to 2/3 of the way into the fitting socket. At this stage there should be an interference fit, tubing should not bottom out in the socket.

4. Solvent Cement Application. USE ONLY CPVC CEMENT CONFORMING TO ASTM F493 OR JOINT FAILURE MAY RESULT. As a result of extensive testing, Lubrizol recommends the application of FlowGuard Gold One Step Cement on 1/2"-2" CTS tubing as the technically preferred method (a primer should be used when joining Corzan IPS pipe and fittings). However, if required by local code, primer, when properly applied, will have no negative effect on FlowGuard Gold CPVC joint integrity. When making a joint, apply a heavy, even coat of cement to the pipe end. Use the same applicator without additional cement to apply a thin coat inside the fitting socket. Too much cement can cause clogged waterways. DO NOT ALLOW EXCESS CEMENT TO PUDDLE IN THE FITTING AND PIPE ASSEMBLY AS THIS MAY LEAD TO PREMATURE FAILURE.

5. Assembly. Immediately insert the tubing into the fitting socket, rotating the tube 1/4 to 1/2 turn while inserting. This motion ensures an even distribution of cement within the joint. Properly align the fitting. Hold the assembly for approximately 10 seconds, allowing the joint to set-up. An even bead of cement should be visible around the joint. If this bead is not continuous around the socket edge, it may indicate that insufficient cement was applied. In this case, remake the joint to avoid potential leaks.



Wipe excess cement from the tubing and fittings surfaces for an attractive, professional appearance.

Cure Times. A joint which has cured sufficient to pressure test may not exhibit its full joint strength. Solvent cement set and cure times are a function of pipe size, temperature, and relative humidity. Curing time is shorter for drier environments, smaller sizes, and higher temperatures. Refer to Table 26 for minimum cure times after the last joint has been made before pressure testing can begin. Use of primer and/or the presence of hot water extends cure time required for pressure testing. Refer to the manufacturer's recommendations for sizes larger than 2".

(Table 26)

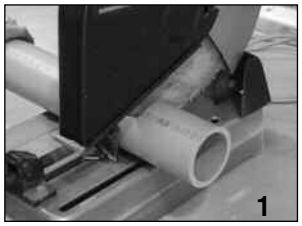
Minimum Cure Prior to Pressure Testing at 100 psi for One Step Solvent Cement

Nominal Pipe Size (in)	Ambient Temperature During Cure Period			
	60°F	40°F	32°F	0°F
1/2	10 min.	10 min.	15 min.	30 min.
3/4	10	15	15	30
1	10	15	20	30
1¼	10	15	20	30
1½	15	15	30	45
2	15	15	30	60

Special care should be exercised when assembling FlowGuard Gold systems in extremely low temperatures (below 40°F) or extremely high temperatures (above 100°F). In extremely hot temperatures, make sure both surfaces to be joined are still wet with cement when putting them together.

Joining Corzan Pipe & Fittings

1. Cutting. Corzan pipe can be easily cut with a mechanical saw or fine-toothed saw. To ensure a square cut, a mitre box should be used. Cutting the pipe as squarely as possible provides maximum bonding area in the most effective part of the joint.



2. Deburring/Beveling. Burrs and filings can prevent proper contact between the pipe and fitting during assembly, and should be removed from both the inside and outside of the pipe using a chamfering tool, file or reamer. A slight bevel should be placed at the end of the pipe to ease entry into the socket and minimize chances of pushing solvent cement to the bottom of the joint.

3. Fitting Preparation. Using a clean dry rag, wipe dirt and moisture from the fitting socket and pipe end. Moisture can slow the curing, and dirt can prevent adhesion.

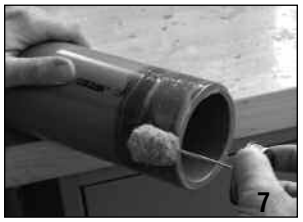
Check the dry fit of the pipe and fitting. For a proper interference fit, the pipe should enter the fitting socket 1/3 to 2/3 of the depth.

4. Initial Fitting Priming. USE PRIMER CONFORMING TO ASTM F656. Using an applicator one-half the size of the pipe diameter, aggressively work the primer into the fitting socket. Re-dip the applicator in the primer as required. Keep the socket and applicator wet until the surface has been softened. Once primed, remove any puddles of primer from the socket.

5. Pipe Priming. Once the fitting socket has been primed, aggressively work the primer around the end of the pipe to a depth of about 1/2" beyond the socket depth.

6. Fitting Re-priming. Apply a second coat of primer to the fitting socket. Immediately, while both surfaces are still tacky, begin the solvent cementing process that follows.

7. Pipe Solvent Cement Application. USE ONLY CPVC SOLVENT CEMENT CONFORMING TO ASTM F493. Acceptable CPVC solvent cements are available that are both orange and gray in color. Verify code requirements for acceptable color of solvent cement. Using an applicator one-half the size of the pipe diameter, aggressively work a heavy, even layer of cement onto the pipe end equal to the depth of the fitting socket.



8. Fitting Solvent Cement Application. Without re-dipping the applicator in the cement, aggressively work a medium layer of cement into the fitting socket. Avoid puddling the cement in the fitting socket.

9. Pipe Reapplication. Apply a second full, even layer of cement on the pipe.

10. Assembly. While the cement is still wet, immediately assemble the pipe and fitting, rotating the pipe 1/4 to 1/2 turn (if possible) until the fitting stop is reached. Hold the assembly together for approximately 30 seconds to avoid push out. A continuous bead of cement should be evident around the pipe and fitting juncture. If the bead is not continuous, sufficient cement was not applied and the joint may be defective. In this case, the fitting should be discarded and the joint reassembled. Wipe excess cement from the pipe and fittings surfaces for an attractive, professional appearance.

Joining Corzan Pipe & Fittings (cont.)

11. Set Time. After a joint is assembled using primer and solvent cement, it should not be disturbed for a period of time to allow for the proper "set" of the newly prepared joint. These times must be adjusted for weather conditions (relative humidity). In damp or humid weather, allow for 50% more set time. Recommended set times are found in Table 27:

(Table 27)

Average Initial Set Times for Corzan IPS Pipe

	Ambient Temperature During Set Period		
Nominal Pipe Size (in)	60-100°F	40-60°F	0-40°F
To 1¼	2 min.	5 min.	10 min.
1½ to 2	5 min.	10 min.	15 min.
2½ to 8	30 min.	2 hr.	12 hr.
10 to 12	2 hr.	8 hr.	24 hr.
15+	4 hr.	16 hr.	48 hr.

Note: For 6" or larger diameter pipe, a pipe puller (come-a-long) is recommended to assemble the joint and hold it in place for the initial set time without applying excess force that may damage the pipe or fitting. This equipment should be set up prior to the start of priming so the assembly can happen quickly while primer and cement are still fluid.

12. Cure Times. A joint which has cured sufficient to pressure test may not exhibit its full joint strength. Solvent cement cure times are a function of pipe size, temperature, and relative humidity. Curing times are shorter for drier environments, smaller sizes, and higher temperatures. Moisture can slow the cure time and reduce joint strength. Reference Table 28 for the minimum cure times after the last joint has been made before pressure testing can begin. The presence of hot water extends the cure time required for pressure testing.

(Table 28)

Minimum Cure Prior to Pressure Testing at 100 psi for Corzan IPS Pipe

	Ambient Temperature During Set Period		
Nominal Pipe Size (in)	60-100°F	40-60°F	0-40°F
To 1¼	15 min.	20 min.	30 min.
1½ to 2	30 min.	45 min.	1 hr.
2½ to 8	1-1/2 hr.	4 hr.	72 hr.
10 to 12	48 hr.	96 hr.	8 days
15+	72 hr.	6 days	14 days

Safety

Lubrizol and manufacturers of FlowGuard Gold and Corzan CPVC pipe fully endorse safety and protective measures recommended by government agencies when installing FlowGuard Gold or Corzan CPVC pipe, other plastic pipe or metal pipe.

- Whenever possible, ensure proper ventilation when applying primers and cements and/or soldering materials.
- Avoid unnecessary skin or eye contact with primers and cements and/or soldering materials. Wash immediately if contact occurs to avoid prolonged exposure.
- Follow all manufacturer-recommended precautions when cutting or sawing pipe or when using any flame, heat or power tools.
- After testing, thoroughly flush the system for at least 10 minutes to remove residual trace amounts of solvent cement or flux/solder components.

Joining a FlowGuard Gold CPVC Component to a Corzan CPVC Component

When making a FlowGuard Gold CPVC to Corzan CPVC solvent cement joint, use only CPVC solvent cement conforming to ASTM F493 and primer conforming to ASTM F656. The joint should be made per the Corzan CPVC joining instructions in this manual.

Do's and Don'ts

While not a complete list, the following is intended to highlight many of the "Do's" and "Don'ts" when joining FlowGuard Gold and Corzan CPVC piping system.

Do's

- Install product according to the manufacturer's installation instructions and this manual.
- Follow recommended safe work practices.
- Follow proper handling procedures.
- Use tools designed for use with plastic pipe and fittings.
- Use proper solvent cement and follow application instructions.
- Cut pipe ends square.
- Deburr and bevel pipe before solvent cementing.
- Rotate the pipe 1/4 to 1/2 turn when bottoming pipe in fitting socket.
- Avoid puddling of solvent cement in fittings and pipe.
- Follow manufacturer's recommended cure times prior to pressure testing.
- Visually inspect all joints for proper cementing at end of the shift or day. A visual inspection of the complete system and all joints is also recommended during pressure testing.

Don'ts

- Do not use solvent cement that exceeds its shelf life or has become discolored or gelled.
- Do not use solvent cement near sources of heat, open flame, or when smoking.
- Do not pressure test until recommended cure times are met.
- Do not use dull or broken cutting tool blades when cutting pipe.

Pressure Testing

Once an installation is completed and cured per the recommendations in Tables 26 and 28, the system should be pressure tested in accordance with local code requirements.

When pressure testing, the system should be filled with water and all air bled from the highest and farthest points in the run. If a leak is found, the joint must be cut out and discarded. A new section can be installed using couplings. During sub-freezing temperatures, water should be blown out of the lines after testing to eliminate potential damage from freezing. When hydrostatic testing is not practical, please refer to the pipe and fittings manufacturer's recommendations.

Hangers and Supports

Horizontal Piping

Horizontal runs of FlowGuard Gold pipe and Corzan pipe should be supported per the hanger support spacing found in Tables 29 and 30 or per code requirements. Piping should not be anchored tightly to supports, but rather secured with smooth straps or hangers that allow for movement caused by expansion and contraction. It is recommended to use full circle talon straps, which cannot pin the pipe tightly against joists or other structures. Hangers should not have rough or sharp edges, which come in contact with the pipe.

Typical pipe hangers.

(Table 29)

FlowGuard Gold Pipe, Hanger/Support Spacing (feet) SDR 11 (ASTM D2846)

Nominal Pipe Size (in)	Maximum Water Temperature			
	73°F	100°F	140°F	180°F
1/2	4	4	3½	3
3/4	5	4½	4	3
1	5½	5	4½	3
1¼	6	5½	5	4
1½	6½	6	5½	4
2	7½	7	6½	4

(Table 30)

Corzan Pipe, Hanger/Support Spacing (feet) Schedule 80 (ASTM F441)

Nominal Pipe Size (in)	Maximum Water Temperature			
	73°F	100°F	140°F	180°F
2½	8	7½	6½	4
3	8	8	7	4
4	9	9	7½	4½
6	10	9½	8	5
8	11	10½	9	5½
10	11½	11	9½	6
12	12½	12½	10½	6½
14	15	13½	11	8
16	16	15	12	8½

Vertical Piping (Risers)

Vertical runs of Corzan pipe should be supported by pipe clamps or by hangers located on the horizontal connection close to the riser. Hangers and straps that do not distort, cut or abrade the piping should be utilized. Maintain vertical piping in straight alignment with supports at each level plus a mid-story guide for pipe sizes 2" and smaller or as specified by the design engineer to allow for expansion/contraction.

Typical riser supports using Corzan pipe.

Typical riser supports using FlowGuard Gold pipe.

Penetration of Studs and Joists

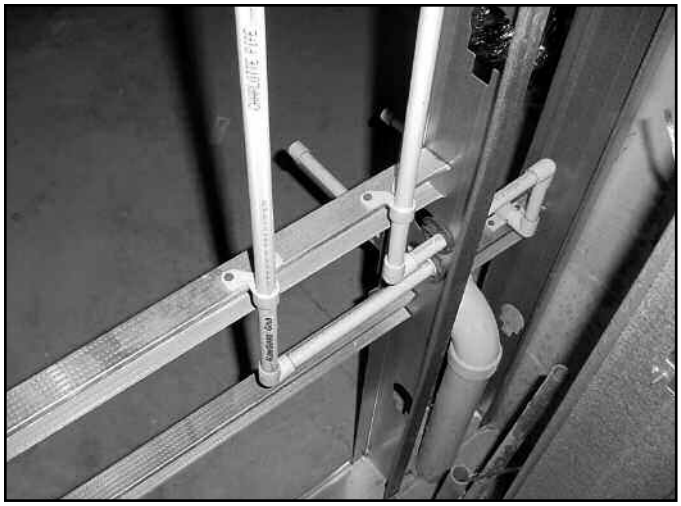
Wooden Studs and Joists

It is acceptable for FlowGuard Gold pipe to pass through wood studs and joists. Insulators, between the CPVC and the wood structure, are not necessary. To permit movement caused by expansion and contraction, holes drilled in the wood joists and studs should be 1/4" larger than the outside diameter of the pipe. Wood or plastic wedges that restrain the pipe as it passes through the wood joist or stud should not be used.

Metal Studs

When FlowGuard Gold pipe passes through metal studs, some form of protection must be used to protect the pipe from abrasion and to prevent noise. This protection may come from plastic insulators, rubber grommets, pipe insulation, or similar devices.

Caution: *Verify the insulating device is chemically compatible with CPVC. Reference the chemical compatibility section of this manual for additional information.*



FlowGuard Gold pipe support at metal studs.

Underslab Installations

When performing underslab installations, it is important that the tube be evenly supported. Backfill should be clean earth, sand, gravel or other approved material, which shall not contain stones, boulders, or other materials that may damage or break the piping. Be sure to account for thermal expansion and contraction, especially in hot water lines. In most cases, expansion and contraction can be accommodated by snaking the pipe from side-to-side along the bottom of the trench. If snaking of the pipe is not practical, expansion loops, offsets or changes in direction can be utilized. Be sure the backfill material will not restrict movement at the expansion loop, offset or change of direction.

The tube should be protected from damage by tools and equipment utilized to finish the concrete. Because CPVC does not react with concrete or stucco and it is inert to acidic soil conditions, it does not need to be sleeved. *Note: Some code jurisdictions require sleeving at slab penetrations. Verify code requirements prior to installation.*

When performing installations underslab, care should be taken to isolate CPVC pipe from direct contact with heavy concentrations of termiticides. Vinyl piping materials such as PVC or CPVC may be damaged by termiticides where they are injected into the annular space between the pipe wall and sleeving material trapping the termiticide against the pipe wall. Light spray applications in an open-air environment should not pose a problem. Common sense precautions will prevent installation problems.

Do's

- If sleeving material is used, verify it is compatible with CPVC.
- If sleeving material is used, securely tape the top of the sleeve to the pipe.
- If sleeving material is used, extend it above and below the slab.
- Backfill and cover underground piping prior to spraying termiticide in preparation for concrete pour.

Don'ts

- Do not allow heavy concentrations of termiticides to come into direct and sustained contact with CPVC pipe.
- Do not inject termiticides into the annular space between the pipe wall and sleeving materials.
- Do not spray termiticide, when preparing a slab, without first backfilling over underground piping.
- Do not cut sleeving too short. If sleeving material is used it should extend above and below the slab.

Joints Underslab

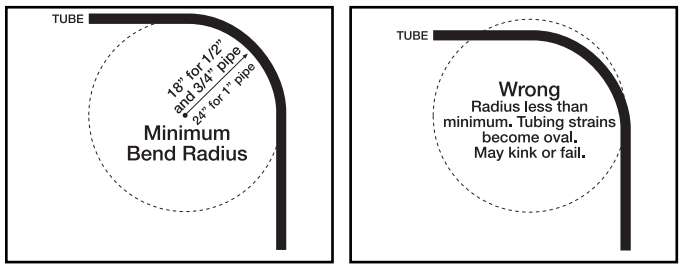
FlowGuard Gold pipe with joints is permitted for underslab installations by all national plumbing codes (verify local code acceptance prior to installation). Underslab installations with joints should be pressure tested prior to pouring the slab.

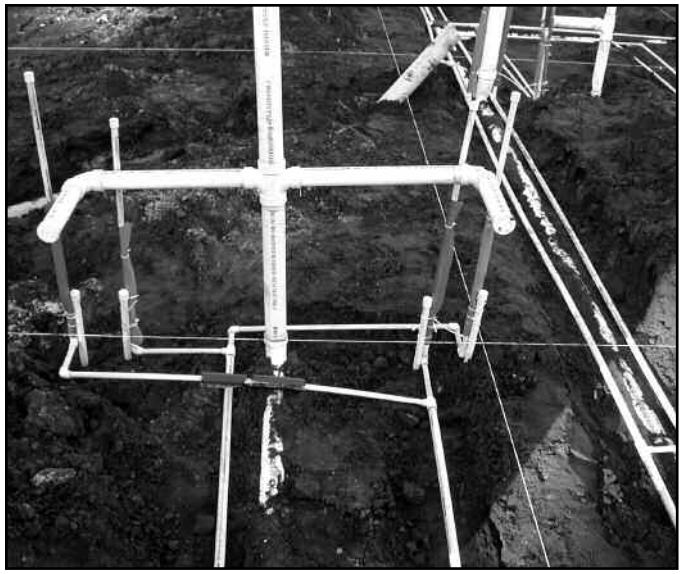
Coiled Pipe

FlowGuard Gold pipe (1/2", 3/4" and 1") is available in coiled form to eliminate the need for joints. When turning the end of coiled pipe up through the slab, into wall, etc., care should be taken not to kink the pipe. Should a kink result, it must be cut out to avoid possible failure. The minimum radius imposed on 1/2" and 3/4" coiled pipe should be 18" and the minimum radius imposed on 1" pipe should be 24" (see Figure 6). Underslab installations without joints do not require a pressure test prior to pouring slab.

Figure 6

Minimum Bend Radius





Long view of FlowGuard Gold joints underslab

Installations Embedded in Concrete

FlowGuard Gold pipe and fittings may be installed embedded in concrete. FlowGuard Gold pipe and fittings are not harmed by direct contact with concrete. In addition to normal installation practices, the following guidelines should be followed:

1. The pipe should be protected from damage by tools and equipment utilized to finish the concrete.
2. Care must be taken to avoid abrasion damage to the pipe and fittings from contact with the wire mesh and/or reinforcing bar. This is mainly a concern before the concrete is poured.
3. Expansion and contraction are not a concern for the pipe and fittings embedded in the concrete. However, proper design considerations must be incorporated in the portion of the system that is not embedded in the concrete. Failure to accommodate expansion and contraction may result in unacceptable stresses where the pipe enters and exits the concrete. Reference the Thermal Expansion and Contraction section of this manual.
4. FlowGuard Gold pipe and fittings are to be joined per the procedures outlined in this manual.
5. Installations with joints embedded in the concrete should be pressure tested prior to pouring the concrete. Installations without joints in the embedded concrete do not require pressure testing prior to pouring the concrete.

Closeup of FlowGuard Gold joints underslab

Water Heater Hook-Ups

Connections

When connecting to a gas water heater, at least six inches of metal nipple or appliance connector should be used so that the CPVC tubing cannot be damaged by build-up of excessive radiant heat from the draft diverter.

Some high-efficiency direct-vent gas water heaters eliminate the radiant heat from the flue and can be piped directly to the water heater. A brass threaded CPVC transition fitting is recommended for this application.

FlowGuard Gold CPVC can also be piped directly to the water heater tapping on an electric water heater. A brass threaded CPVC transition fitting is recommended for this application. *Note: Some code jurisdictions require metal connections on all water heaters. Verify code requirements prior to installation.*

T/P Relief Valve Drain Lines

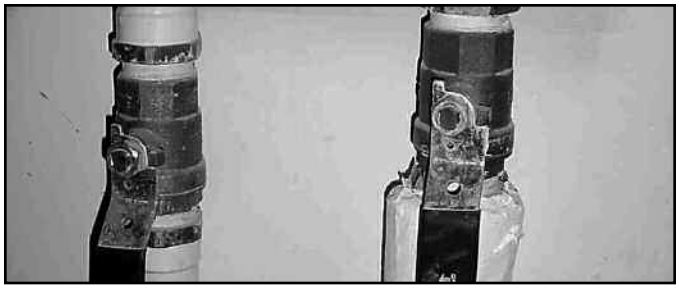
FlowGuard Gold CPVC is an excellent material for T/P relief valve drain lines and is specifically approved by each of the model codes for this application.

Although FlowGuard Gold CPVC is rated for 100 psi at 180°F, it is suitable for the higher temperature of 210°F, because the pressure is nearly 0 psi for a discharge pipe that is open to the atmosphere. Water heater temperature relief valves are generally set to open at 210°F.

Valves for Use with CPVC

A variety of valves are commonly available for use with CPVC pipe. Valves made from FlowGuard Gold and Corzan CPVC are utilized in many applications. Various connection methods (solvent cement, threaded, flanged, etc.) can be utilized to transition from the pipe to the valve.

Commonly available CPVC valves.



Valves installed with FlowGuard Gold pipe.

Butterfly valves installed with Corzan pipe.

Transition to Other Materials

Support

Additional support should be added at the metal side of a FlowGuard Gold or Corzan CPVC to metal transition to support the weight of the metal system.

Compression Connections Utilizing Brass Ferrules

Standard compression fittings which utilize brass ferrules can be used on FlowGuard Gold CPVC tubing. The compression fitting should be installed per the limitations and instructions of the fitting manufacturer. In addition, the following guidelines should be followed:

1. Teflon tape must be applied over the ferrule to compensate for the dissimilar thermal expansion rates of the brass and CPVC.
2. Care should be excercised not to over-torque the compression connection.
3. Compression connections are not recommended when the operation temperature is expected to exceed 140°F.

Threaded Connections

Numerous male and female transition fittings are available. Temperature and pressure limitations should comply with the recommendation of the manufacturer of the fitting. Care should be used not to over-torque CPVC threaded fittings.

Thread Sealants

TFE (Teflon®) thread tape is always safe for making CPVC threaded connections. Some paste-type sealants contain solvents that may be damaging to CPVC. If the use of a paste or pipe dope is preferred, always check with the manufacturer regarding its compatibility with CPVC. Use of an improper paste or dope can result in failure of CPVC systems. (Refer to the chemical compatibility section of this manual for *additional* information on compatibility)

Threaded transition fittings.

Flanged Connections

Flanging can be used to provide temporary disassembly of a piping system, for connection to valves or other devices, or when it is not possible to make up solvent cemented joints at the assembly site. Flanged joints incorporate an elastomeric gasket between the mating faces to provide for a seal. The gasket selected must be full-faced and have a hardness of 55-80 durometer A. Typically, gaskets are 1/8" thick. If the piping system is for potable water service, the gasket must be approved for potable water.

The flanges should be carefully aligned and the bolts inserted through matching holes. A flat washer should be used beneath each nut and bolt head. Each bolt should be partially tightened in the alternating sequence indicated in Figure 7. A torque wrench should be used for the final tightening of the bolts. The bolts should be tightened to the torque recommended in Table 31 in the same alternating sequence used previously.

Flange joints are typically rated to 150 psi at 73°F. For systems operating at higher temperatures, the flange pressure rating should be derated per the manufacturer's instructions.

(Table 31)

Recommended Bolt Torque

Nominal Pipe Size (in)	Number of Bolt Holes	Bolt Diameter (in)	Recommended Torque (ft-lbs)*
1/2 to 1½	4	1/2	10-15
2-3	4	5/8	20-30
4	8	5/8	20-30
6	8	3/4	33-50
8	8	3/4	33-50
10	12	7/8	53-75
12	12	1	80-110

*Consult the manufacturer's literature for recommended torques.

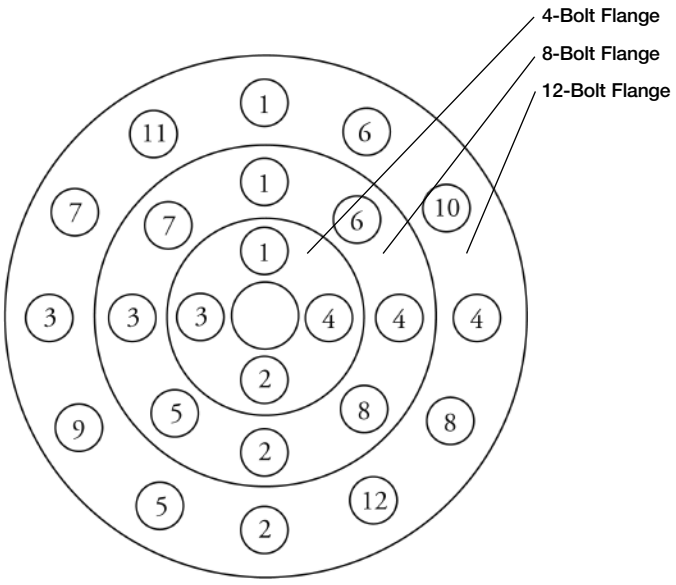


Figure 7

Flange Bolt Tightening Patterns

Other Design Criteria

Water Hammer Arrestors

FlowGuard Gold pipe and fittings have excellent insulation properties which effectively absorb the shock waves generated by solenoid operating valves. The use of water hammer arrestors or air chambers is not required for domestic installations. Should FlowGuard Gold or Corzan pipe and fittings be used where severe and repeated water hammer might be encountered at elevated temperatures, such as a commercial laundry, the use of a water hammer arrestor is advisable.
Note: Some code jurisdictions require water hammer arrestors. Verify code requirements prior to installation.

Freeze Issues

CPVC is a ductile material, which expands and contracts more than metallic plumbing pipe. However, CPVC, like all other piping materials, needs to be protected from freezing. All model plumbing codes require that piping exposed to freezing temperatures be properly insulated.

If water filled CPVC pipe becomes frozen, immediate action should be taken to eliminate the source of air causing the freeze condition. Then thaw the water line, if possible. When thawing a frozen CPVC water line, it is important to remember to limit the heat source to 180°F or less.

If the frozen section of pipe is accessible, heated air can be blown directly onto the freeze area by using a low wattage heater/blower. A second option is to apply electrical heat tapes to the problem area.

Thermal Conductivity, Condensation and Sweating

In general, plastic materials have low coefficients of thermal conductivity when compared with metallic materials (reference Table 32). Because of the low coefficient of thermal conductivity, it is generally not necessary to insulate FlowGuard Gold or Corzan CPVC hot and cold water supply lines within conditioned buildings. Verify code requirements, as some energy codes require hot water recirculating lines to be insulated. Following are some factors to support this:

- CPVC piping carrying 180°F water will have an outside surface temperature of about 150°F in a conditioned building.
- Copper tube carrying 180°F water will have an outside surface temperature of about 180°F in a conditioned building.
- If hot water is not circulated through the line, both CPVC and copper pipe will cool to ambient temperature in a short time.
- Under most conditions that cause copper tube to sweat and drip, FlowGuard Gold pipe will remain free of condensation.

Thermal conductivity is defined as "transfer of heat from one part of a body to another part of the same body, or from one body to another in physical contact with it, without appreciable displacement of the particles of the body." This definition leads to the commonly used "k" factor, which refers to thermal conductivity.

(Table 32)

Thermal Conductivity Comparison

Material	Thermal Conductivity - k BTU-in/hr-ft^2-F
Insulation	0.25
CPVC	0.95
Steel	324
Copper	2688

Hot Water Recirculating Systems and Hydronic Heat Applications

FlowGuard Gold pipe and fittings are ideal for both hot water recycling systems and hydronic heat applications. Reference the Hydronic Heat Applications section of this manual for additional information. FlowGuard Gold pipe and fittings are rated for **continuous** pressure service of 100 psi at 180°F. The system design temperature/pressure must fall at or below the rated temperature/pressure limitations of the pipe. The system should be designed and installed per the guidelines of this manual and the pipe and fittings manufacturer's installation instructions.

Chemical Compatibility

CPVC domestic water, fire sprinkler, and industrial piping systems have been used successfully for nearly 50 years in new construction, re-pipe and repair. CPVC products are ideally suited for these applications due to their outstanding corrosion resistance. Occasionally, however, CPVC and PVC can be damaged by contact with chemicals found in some construction products (and site preparations). Reasonable care needs to be taken to ensure that products coming into contact with CPVC systems are chemically compatible. Lubrizol recommends that chemical compatibility with CPVC be confirmed with the manufacturer of the product in contact with CPVC piping systems. If chemical compatibility with CPVC is in question, Lubrizol recommends isolating the suspect product from contact with CPVC pipe or fittings.

Lubrizol maintains a list of products that have been shown to be **UNACCEPTABLE** for (unprotected use) contact with CPVC systems. Chemically incompatible products are added to this list as they are brought to our attention. For the most current list of chemically incompatible products, contact Lubrizol or refer to **www.systemcompatible.com.** A product's absence from this list does not imply or ensure CPVC chemical compatibility.

ALWAYS CHECK THE PRODUCT MANUFACTURER'S RECOMMENDATION IN THIS REGARD.

FGG =BM= CZ™
SYSTEM COMPATIBLE

The FGG/BM/CZ™ System Compatible Program

The FGG/BM/CZ System Compatible Program is designed to test and monitor ancillary products on an ongoing basis to ensure chemical compatibility with FlowGuard Gold and Corzan water distribution systems

and BlazeMaster® fire sprinkler systems. For the most up to date list of products that meet the standards and are deemed to be FGG/BM/CZ System Compatible, refer to **www.systemcompatible.com.**

Painting

Water-based acrylic latex paint is the preferred and recommended paint to use on FlowGuard Gold and Corzan pipe and fittings. Oil or solvent-based paints may be chemically incompatible.

Penetrating Fire Rated Walls, Floors and Ceilings

Building codes require penetrations through fire rated walls, floors and ceilings to be protected with approved penetration firestop systems. A number of firestop manufacturers have systems that are listed for use with CPVC pipe. Consult the UL Fire Resistive Directory, Warnock Hersey Certification Listing, or the PPFA Plastic Pipe in Fire Resistive Construction Manual for a listing of products.

Some firestop sealants or wrap strips contain solvents or plasticizers that may be damaging to CPVC. Always consult the manufacturer of the firestop material to confirm chemical compatibility with CPVC pipe and fittings. *(Refer to the chemical compatibility section of this manual for additional information on compatibility.)*

Combustibility of CPVC

Ignition Temperature. CPVC has a flash ignition temperature of 900°F which is the lowest temperature at which sufficient combustion gas is evolved that can be ignited by a small external flame. Many other ordinary combustibles, such as wood, ignite at 500°F or less.

Burning Resistance. CPVC will not sustain burning. It must be forced to burn due to its very high Limiting Oxygen Index (LOI) of 60. LOI is the percentage of oxygen needed in an atmosphere to support combustion. Since the Earth's atmosphere is only 21% oxygen, CPVC will not burn unless a flame is constantly applied, and stops burning when the ignition source is removed.

CPVC cannot be the ignition source of a fire or support combustion.

(Table 33)

Limiting Oxygen Index (LOI)
Oxygen contained in Earth's atmosphere - 21%

Material	LOI
Cotton	16-17
Polypropylene	18
Birch	20
CPVC	60

Flame/Smoke Spread Development Rating

In many commercial buildings, the area above the suspended ceiling is used as a return air plenum. The building codes restrict the kinds of materials that can be installed in air plenums. Various tests are used to evaluate surface burning characteristics of construction materials. The most common reference is to restrict materials allowed within plenums to those meeting a 25/50 flame spread/smoke developed criteria when tested in accordance with UL 723/ASTM E84, "Standard Test Method for Surface Burning Characteristics of Building Materials" (NFPA 255 and UBC 8-1). As a comparison to the 25/50 requirement, asbestos cement has a 0/0, and red oak wood has a 100/100 flame spread/smoke developed rating.

An independent testing laboratory has tested water filled 1/2" and 2" FlowGuard Gold pipe, 1/2" and 3/4" empty FlowGuard Gold pipe, and water filled 1/2" and 6" SCH 80 Corzan pipe in general accordance with UL 723/ASTM E84. Test results indicate that all materials gave a flame and smoke rating less than 25/50. *(Contact Lubrizol for a copy of the test report.)*

Hydronic Heating Applications

Tables 34 and 35 highlight key points to remember when installing FlowGuard Gold or Corzan CPVC in a hydronic radiant heating application. A hydronic radiant heating application is defined here as piping directly off a hot water heater or boiler into a coil heating unit in single- or multi-family homes.

Do's for all hydronic applications

- Only install in accordance with pipe, fittings and solvent cement manufacturer's recommendations and installation instructions.
- Follow recommended safe work practices.
- The system operating temperature/pressure should not exceed the temperature/pressure rating of the piping system.
- Verify that the maximum outlet temperature and pressure of the boiler is less than the temperature and pressure rating of the pipe (see charts below).
- Always use the proper derating factors with FlowGuard Gold and Corzan pipe to find the pressure ratings at the applicable operating temperature.
- Always follow local codes and approvals when installing plumbing and heating equipment.
- Ensure that the system design allows for thermal expansion and contraction as recommended in this manual.
- Use only CPVC-x-metal transition adapters if using threaded connections.
- Pay close attention to proper use of good solvent cementing practices, including beveling and proper dauber sizing.
- Additional support should be added to the metal side of a CPVC-x-metal transition or other metallic components to support the weight of the metal system.
- Use check valves, heat traps or back flow prevention to prevent cross-connections between hot and cold water lines.
- Flush the interior of heat exchangers or the exterior of condenser coils thoroughly with mild ionic detergent solution to remove incompatible oils prior to piping installation.
- Use a rinse with clean water to purge the system as a final flushing.
- Verify that all boiler cleaning and sealing chemicals used in the hydronic radiant heating system are compatible with CPVC.

Don'ts for all hydronic applications

- Do not use 100% CPVC threaded adapters, male or female.
- Do not use the CPVC piping system to support any metallic components.
- Do not use compression fittings for hydronic radiant heating applications that will operate above 140°F.
- Do not use solvent cement that exceeds its shelf life or has become discolored or gelled.
- Do not use CPVC tees or other CPVC components as mixing devices.
- Do not over solvent-cement the joints. Puddling of solvent cement must be avoided.
- Do not rely on an expansion tank to handle thermal expansion of the piping system. Expansion tanks accommodate expansion of the fluid, not longitudinal expansion of the pipe. The piping system must be designed to allow for thermal expansion.

(Table 34)

FlowGuard Gold Pressure Rating Chart (psi)

Nominal Pipe Size (in)	73°F	80°F	120°F	140°F	180°F
ALL (SDR-11)	400	328	260	200	100

(Table 35)

Corzan Schedule 80 Pressure Rating Chart (psi)

Nominal Pipe Size (in)	73°F	100°F	120°F	140°F	180°F
1/2	850	697	553	425	213
3/4	690	566	449	345	173
1	630	517	410	315	158
1¼	520	426	338	260	130
1½	470	385	306	235	118
2	400	328	260	200	100
3	370	303	241	185	93
4	320	262	208	160	80
6	280	230	182	140	70
8	250	205	163	125	63

Do's and Don'ts for All Construction

While not a complete list, the following is intended to highlight many of the "Do's" and "Don'ts" addressed in this manual.

Do's FOR ALL CONSTRUCTION

- Install product according to the manufacturer's installation instructions and this manual.
- Follow recommended safe work practices.
- Make certain that thread sealants, gasket lubricants and firestop materials are compatible with CPVC pipe and fittings.
- Use only latex-base paints if painting is desired.
- Keep pipe and fittings in original packaging until needed.
- Cover pipe and fittings with opaque tarp if stored outdoors.
- Follow proper handling procedures.
- Use tools designed for use with plastic pipe and fittings.
- Use proper solvent cement and follow application instructions.
- Cut pipe ends square.
- Deburr and bevel pipe before solvent cementing.
- Rotate the pipe 1/4 to 1/2 turn when bottoming pipe in fitting socket.
- Avoid puddling of solvent cement in fittings and pipe.
- Follow manufacturer's recommended cure times prior to pressure testing.
- Fill lines slowly and bleed the air from the system prior to pressure testing.
- Allow for movement due to expansion and contraction.
- Use plastic pipe straps that fully encircle the tube.
- Drill holes 1/4" larger than the outside diameter of the tube when penetrating wood studs.
- Use protective pipe isolators when penetrating steel studs.
- Use metallic or tear drop hangers when suspending tube from all thread rod.
- Visually inspect all joints for proper cementing at the end of the shift or day. A visual inspection of the complete system and all joints is also recommended during pressure testing.

FOR UNDERSLAB CONSTRUCTION

- If sleeving material is used, verify it is compatible with CPVC.
- If sleeving material is used, securely tape the top of the sleeve to the pipe.
- If sleeving material is used, extend it 12" above and below the slab.
- Backfill and cover underground piping prior to spraying termiticide in preparation for concrete pour.

Don'ts FOR ALL CONSTRUCTION

- Do not use petroleum or solvent-based paints, sealants, lubricants or firestop materials.
- Do not use edible oils such as Crisco® for a lubricant.
- Do not use solvent cement that exceeds its shelf life or has become discolored or gelled.
- Do not use solvent cement near sources of heat, open flame, or when smoking.
- Do not pressure test until recommended cure times are met.
- Do not use dull or broken cutting tool blades when cutting pipe.
- Do not restrict expansion/contraction.
- Do not install in cold weather without allowing for thermal expansion.
- Do not use tube straps which tend to over tighten the system.
- Do not use wood or plastic wedges that restrain tube as it passes through wood studs.
- Do not bend CPVC tube around DWV stacks causing the two materials to bind against each other.
- Do not terminate a run of tube against an immovable object (e.g., floor joist).

FOR UNDERSLAB CONSTRUCTION

- Do not allow heavy concentrations of termiticides to come into direct and sustained contact with CPVC pipe.
- Do not inject termiticides into the annular space between the pipe wall and sleeving material.
- Do not spray termiticides, when preparing the slab, without first backfilling over underground piping.
- Do not cut sleeving material too short. If sleeving material is used, it should extend 12" above and below the slab.

Sample Specifications*

FlowGuard Gold CPVC Pipe and Fittings

PART 1 - GENERAL

1.0 PRODUCT DESCRIPTION

FlowGuard Gold CPVC CTS pipe and fittings are extruded/molded from CPVC compounds. The pipe compound shall meet cell class 24448 and the fitting compound shall meet cell class 23447 as defined by ASTM D1784. Both the pipe and the fitting compounds shall be certified by NSF International for use with potable water.

1.1 PIPE AND FITTINGS

A. Pipe and fittings shall meet or exceed the requirements of ASTM D2846.

B. To ensure that a complete system is installed, the CPVC compounds used to manufacture pipe and fittings shall be produced by the same compound manufacturer.

C. The CPVC compound manufacturer shall conduct a program that lists those ancillary building products (including, but not limited to fire stops, thread sealants, and leak detectors) that are chemically compatible with their CPVC compounds. This compatibility program shall be administered by an independent third party testing agency.

D. CPVC compound shall be produced by an ISO certified manufacturer.

1.2 SOLVENT CEMENT

All socket type joints shall be assembled employing solvent cements that meet or exceed the requirements of ASTM F493. The standard practice for safe handling of solvent cements shall be in accordance with ASTM F402. Solvent cement shall be listed by NSF International for use with potable water, and approved by the pipe and fittings manufacturers.

1.3 BASIC USE

A. FlowGuard Gold CPVC CTS pipe and fittings are intended for use in hot and cold potable water distribution systems in single and multi-family homes, apartments, high-rises, hotel/motels, and commercial installations.

B. Water filled FlowGuard Gold CPVC CTS pipe and fittings (1/2" through 2") tested in general accordance with UL 723/ASTM E84 (NFPA 255 and UBC 8-1) shall meet the 25/50 flame and smoke requirement and shall be permitted to be installed in return air plenums. Test reports from a third party testing laboratory shall be obtained and made available upon request.

PART 2 – PRODUCTS

2.0 MATERIALS

The piping systems shall be constructed from materials extruded/molded by manufacturers using the same CPVC compound manufacturer.

2.1 MANUFACTURERS

A. PIPE AND/OR FITTINGS

Bow Industrial Corp.
104 Sharron Avenue
Plattsburgh, NY 12901
Phone (518) 561-0190
FAX (518) 561-6277

Charlotte Pipe and Foundry Co.
P.O. Box 35430
Charlotte, NC 28235
Phone (704) 372-5030
FAX (704) 348-6450

Cresline Plastic Pipe Co.
600 Cross Point Blvd.
Evansville, IN 47715
Phone (812) 428-9300
FAX (812) 428-9353

Genova Products, Inc.
7034 E. Court Street
Davison, MI 48423-0309
Phone (810) 744-4500
FAX: (810) 744-1653

Harvel Plastics, Inc.
P.O. Box 757
Kuebler Road
Eaton, PA 18044
Phone (610) 252-7355
FAX (610) 253-4446

King Bros. Industries
29101 The Old Road
Valencia, CA 91355
Phone (800) 325-9468
FAX (661) 257-4320

NIBCO, Inc.
1516 Middlebury Street
Elkhart, IN 46515-1167
Phone (800) 234-0227
FAX (800) 234-0557

B. BALL VALVES

King Bros. Industries
27781 Avenue Hopkins
Valencia, CA 91355
Phone (805) 257-3262
FAX (805) 257-4320

NIBCO, Inc.
1516 Middlebury Street
Elkhart, IN 46515-1167
Phone (800) 234-0227
FAX (800) 234-0557

C. SOLVENT CEMENTS

Fry Technology
1661 Old Dixie Highway
Riviera Beach, FL 33404
Phone (561) 844-0241
FAX (561) 848-8958

IPS Corporation
455 West Victoria Street
Compton, CA 90220
Phone (310) 898-3300
FAX (310) 898-3392

Schwartz Chemical of Canada Ltd.
777 McKay Road
Pickerington, ON L1W 3A3
Phone (905) 683-0411
FAX (905) 428-2057

The Oatey Company
4700 W. 160th St.
Cleveland, OH 44135
Phone (216) 267-7100
FAX (216) 267-6538

PART 3 – EXECUTION

3.0 SYSTEM DESIGN

A. System design shall be in accordance with standard industry practice for water distribution systems and the manufacturer's instructions. The design shall take into consideration such factors as pressure and flow requirements, friction loss, operating temperatures, support spacing, joining methods, and thermal expansion and contraction.

B. A Hazen-Williams C Factor of 150 shall be used in all hydraulic calculations.

C. The maximum design temperature/pressure rating shall not exceed 100 psi at 180°F (400 psi at 73°F).

3.1 INSTALLATION PROCEDURES

Installation practices such as pipe support spacing, bracing, allowance for thermal expansion/contraction, solvent cementing and handling and storage shall be in accordance with the manufacturer's instructions and this specification.

3.2 LIMITATIONS

FlowGuard Gold CPVC CTS pipe and fittings are intended for use at a maximum working pressure of 100 psi at 180°F (400 psi at 73°F).

3.3 TECHNICAL DATA

A. APPLICABLE STANDARDS

1. ANSI/NSF Standard 14 Plastic Piping Components and Related Materials
2. ANSI/NSF Standard 61 Drinking Water System Components – Health Effects
3. ASTM D1784 Specification for Rigid Poly (Vinyl Chloride)(PVC) Compounds and Chlorinated Poly (Vinyl Chloride)(CPVC) Compounds
4. ASTM D2846 Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
5. ASTM F493 Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) CPVC Plastic Pipe and Fittings
6. CSA B137 CPVC Pipe, Tubing and Fittings for Hot and Cold Water Distribution Systems

B. APPLICABLE CODES

1. BOCA, Basic Building, Mechanical Plumbing Codes
2. IAPMO, Uniform Plumbing Code
3. ICC, International Building, Mechanical and Plumbing Codes
4. ICBO, Uniform Building and Mechanical Codes
5. SBCCI, Standard Building, Mechanical and Plumbing Codes
6. National Building Code of Canada
7. Canadian Plumbing Code

3.4 TESTING

After the system is installed and any solvent cement is cured, the system shall be hydrostatically tested per the manufacturer's installation instructions and the requirements of the applicable plumbing or mechanical code.

3.5 WARRANTY

Consult the manufacturer for specific warranty information.

*Not intended to be a stand alone specification. The above specification is intended to be added within your company's standard plumbing specifications to specify the use of FlowGuard Gold CPVC CTS pipe and fittings.

Corzan CPVC Pipe and Fittings

PART 1 – GENERAL

1.0 PRODUCT DESCRIPTION

Corzan CPVC Schedule 80 IPS pipe and fittings are extruded/molded from CPVC compounds. The pipe compounds shall meet cell class 24448 (available through 6" and up to 8" from select manufacturers) or 23447 for pipe 8" or greater as defined by ASTM D1784. The pipe shall be certified by NSF International for use with potable water.

Corzan CPVC Schedule 80 IPS fittings compound shall meet cell class 23447 and carry a pressure rating listed by PPI (Plastics Pipe Institute). This Corzan CPVC Schedule 80 IPS compound shall be pressure rated in accordance with ASTM D2837 and PPI TR-3 and have hydrostatic design bases of 4000 psi at 72°F and 1000 psi at 180°F as listed in PPI publication TR-4.

1.1 PIPE AND FITTINGS

A. Pipe shall meet or exceed the requirements of ASTM F441 in Schedule 80.

B. Fittings shall meet or exceed the requirements of ASTM F437 (Schedule 80 threaded), and ASTM F439 (Schedule 80 socket).

C. To ensure that a complete system is installed, the CPVC compounds used to manufacture pipe and fittings shall be produced by the same compound manufacturer.

D. The CPVC compound manufacturer shall conduct a program that lists those ancillary building products (including, but not limited to: fire stops, thread sealants, and leak detectors) that are chemically compatible with its CPVC compounds. This compatibility program shall be administered by an independent third party testing agency.

E. CPVC compound shall be produced by an ISO certified manufacturer.

1.2 SOLVENT CEMENT

All socket type joints shall be assembled employing solvent cements that meet or exceed the requirements of ASTM F493 and primers that meet or exceed the requirements of ASTM F656. The standard practice for safe handling of solvent cements shall be in accordance with ASTM F402. Solvent cement and primer shall be listed by NSF International for use with potable water, and approved by the pipe and fittings manufacturers.

1.3 BASIC USE

A. Corzan CPVC Schedule 80 IPS pipe and fittings are intended for use in both pressure and drain applications in hot and cold potable water distribution systems, general chemical plants, pulp and paper mills, water treatment plants, metal treating/electroplating plants, water purification plants and food processing plants.

B. Water filled Corzan CPVC Schedule 80 IPS pipe and fittings (1/2" through 6") tested in general accordance with UL 723/ASTM E84 (NFPA 255 and UBC 8-1) shall meet the 25/50 flame and smoke requirement and shall be permitted to be installed in return air plenums. Test reports from a third party testing laboratory shall be obtained and made available upon request.

PART 2 – PRODUCTS

2.0 MATERIALS

The piping systems shall be constructed from materials extruded/molded by manufacturers using the same CPVC compound manufacturer.

2.1 MANUFACTURERS

A. PIPE AND/OR FITTINGS

Charlotte Pipe and Foundry Co.
P.O. Box 35430
Charlotte, NC 28235
Phone (800) 438-6091
FAX (800) 553-1605

Harvel Plastics, Inc.
P.O. Box 757
Easton, PA 18044-0757
Phone (610) 252-7355
FAX (610) 253-4436

NIBCO, Inc.
1516 Middlebury Street
Elkhart, IN 46515-1167
Phone (800) 234-0227
FAX (800) 234-0557

IPEX, Inc. (US)
10100 Rodney Street
Pineville, NC 28134
Phone (800) 463-9572
FAX (905) 403-9195

IPEX, Inc. (Canada)
6810 Invader Crescent
Mississauga, ON L5T 2B6
Canada
Phone (866) 473-9472
FAX (905) 670-5295

B. VALVES

CEPEX USA, Inc.
13291-106 Vantage Way
Jacksonville, FL 32218
Phone: (904) 695-1441
Fax: (904) 695-1442

Hayward Industrial Products
One Hayward Industrial Dr.
Clemmons, NC 27012-5100
Phone: (888) 429-4635
Fax: (888) 778-8410
Toll Free–Pomona, CA:
(800) 548-7665
Fax–Pomona, CA:
(909) 594-7951

IPEX, Inc. (US)
10100 Rodney Street
Pineville, NC 28134
Phone: (800) 463-9572
Fax: (905) 403-9195

IPEX, Inc. (Canada)
6810 Invader Crescent
Mississauga, ON L5T 2B6
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Phone: (866) 473-9472
Fax: (905) 670-5295

NIBCO, Inc.
1516 Middlebury Street
Elkhart, IN 46515-1167
Phone (800) 234-0227
FAX (800) 234-0557

Plast-O-Matic Valves, Inc.
1384 Pompton Avenue
Cedar Grove, NJ 07009
Phone: (973) 256-3000
Fax: (973) 256-4745

C. SOLVENT CEMENT

IPS Corporation
455 West Victoria Street
Compton, CA 90220
Phone (800) 421-2677
FAX (310) 898-3392

The Oatey Company
4675 W. 160th St.
Cleveland, OH 44135
Phone: (216) 267-7100
Fax: (216) 267-6538

PART 3 - EXECUTION

3.0 SYSTEM DESIGN

A. System design shall be in accordance with standard industry practice for water distribution systems and the manufacturer's instructions. The design shall take into consideration such factors as pressure and flow requirements, friction loss, operating temperatures, support spacing, anchoring, bracing and thrust blocking, joining methods, and thermal expansion and contraction.

B. A Hazen-Williams C Factor of 150 shall be used in all hydraulic calculations.

C. Maximum design temperature/pressure ratings shall not exceed as found in Table 36:

(Table 36)

Maximum Design Temperature/Pressure Ratings

Nominal Pipe Size (in)	Maximum Water Pressure (psi) Schedule 80*
1/2	850
3/4	690
1	630
1¼	520
1½	470
2	400
2½	420
3	370
4	320
6**	280
8**	250
10**	230
12**	230
14**	220
16**	220

**Pressure rating applies for water at 73˚F.*
For temperatures greater than 73˚F, see derating factor in Section 3.0 F.

***Corzan CPVC Schedule 80 pipe 6" or larger shall not be threaded.*
Corzan CPVC Schedule 80 pipe operating above 130˚F shall not be threaded.

D. *Pressure Rating for Flanged System*
Flanged systems of any size shall not exceed 150 psi working pressure.

E. *Pressure Ratings for Threaded Systems*
Schedule 80 pipe operating above 130°F shall NOT be threaded. Threaded pipe shall be derated to 50% of the pressure rating for the piping at the system operating temperature.

F. ***Temperature Derating Factors***

Working Temperature (˚F)	Pipe Derating Factor
73-80	1.00
90	0.91
100	0.82
120	0.65
140	0.50
160	0.40
180	0.25
200	0.20

G. *Joining Systems*

1. Integrating of pipe and fittings shall be done by solvent cementing, threading or flanging.

2. Solvent cement that meets or exceed the requirements of ASTM F493 shall be used in conjunction with a primer/cleaner as manufactured by companies listed in Section 2.1 C.

3. Flanges shall be installed on pipe ends with CPVC primer/cleaner and CPVC solvent cement and then bolted together per the manufacturer's instructions and torque ratings.

4. Threading may be performed on Corzan CPVC Schedule 80 pipe 4" and smaller, per the manufacturer's instructions. Threads shall be in accordance with ANSI B1.20.1 Taper Pipe Thread.

3.1 INSTALLATION PROCEDURES

Installation practices such as pipe support spacing, bracing, allowance for thermal expansion/contraction, solvent cementing and handling and storage shall be in accordance with the manufacturer's instructions and this specification.

3.2 LIMITATIONS

Temperature derating factors shall be applied when operating temperatures exceed 73°F.

3.3 TECHNICAL DATA

A. APPLICABLE STANDARDS

1. ANSI/NSF Standard 14 Plastic Piping Components and Related Materials

2. ANSI/NSF Standard 61 Drinking Water System Components – Health Effects

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

4. ASTM D2855 Standard Practice for Making Solvent Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings

5. ASTM F402 Practice for Safe Handling of Solvent Cements, Primers and Cleaners Used for Joining Thermoplastics Pipe and Fittings

6. ASTM F437 Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

7. ASTM F439 Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

8. ASTM F441 Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedule 40 and 80

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

10. ASTM F656 Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

B. APPLICABLE CODES

1. BOCA, Basic Building, Mechanical and Plumbing Codes

2. IAPMO, Uniform Plumbing Code

3. ICC, International Building, Mechanical and Plumbing Codes

4. ICBO, Uniform Building and Mechanical Codes

5. SBCCI, Standard Building, Mechanical and Plumbing Codes

3.4 TESTING

After the system is installed and solvent cement is cured, the system shall be hydrostatically tested per the requirements of the applicable plumbing or mechanical code.

3.5 WARRANTY

Consult the manufacturer for specific warranty information.

*Not intended to be a stand alone specification. The above specification is intended to be added within your company's standard plumbing specifications to specify the use of Corzan CPVC Schedule 80 IPS pipe and fittings.

FBC™ Building Solutions
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Cleveland, Ohio 44141-3201 USA
888-234-2436 ext. 447-7393
216-447-5000
FAX: 216-447-5750

www.fbcbuildingsolutions.com

Avenida Interceptor Pte. #69
Parque Industrial La Joya
Cuautitlán, Izcalli – Mexico City
Edo. de México 54730
52-55-3067-0860
FAX: 52-55-5870-8956

100 Regina Street South
Suite 360
Waterloo, Ontario
Canada N2J 4P9
519-888-3330
FAX: 519-888-3337

FlowGuard Gold® Pipe and Fittings Manufacturers

BOW	CHARLOTTE PIPE AND FOUNDRY COMPANY	CRESLINE® CRESLINE PLASTIC PIPE CO., INC.	Genova PRODUCTS	HARVEL PLASTICS, INC.	kbi	NIBCO AHEAD OF THE FLOW™
518-561-0190	704-372-5030	812-428-9300	810-744-4500	610-252-7355	800-325-9468	800-234-0227
www.bow-group.com	www.charlottepipe.com	www.cresline.com	www.genovaproducts.com	www.harvel.com	www.kbico.com	www.nibco.com

Corzan® Pipe and Fittings Manufacturers

CHARLOTTE PIPE AND FOUNDRY COMPANY	HARVEL PLASTICS, INC.	IPEX Committed to Excellence	NIBCO AHEAD OF THE FLOW™
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