Pipe is identified by markings required continuously along its length. Markings must include the manufacturer, the model designation, or schedule. Pipe listed for fire protection use must bear the listing number.

Pipe Materials

Materials used in fire protection systems must be listed for the intended use unless otherwise allowed by the applicable standard. Underground pipe must be listed for fire protection service.

Ferrous (iron based) pipe may be welded or seamless. Unlisted pipe used for aboveground installations must meet the manufacturing standards listed in the tables.

Pipe clamps used for the restraint of plastic pipe can be unlisted only if the clamp is padded to prevent scoring of the piping. Sprinkler systems installed in one-and two-family dwellings typically use plastic pipe concealed in construction. Exposed pipe in attics must be copper or steel.

NFPA 13
2-3.1

Pipe used for underground and aboveground fire protection water supply piping, including risers, mains, and branchlines must be listed for fire protection use or meet the standards of NFPA 13 Table 2-3.1.

Underground Pipe

NFPA 24

7-1.1

Piping used for underground water delivery to fire protection systems must be listed for fire protection service and comply with AWWA (American Waters Works Association) standards when connected to the potable water supply.

Polyvinyl Chloride (PVC) underground pipe is known as ‘pressure pipe’. Plastic municipal water pipe up to 12 inches must meet AWWA C900 specifications (suitable for potable water). There are three pressure classes for C900 plastic (PVC) pipe. Class 150 is the minimum pressure class allowed for fire service.

See NFPA 24 7-1.3. Where underground fire protection systems are pressurized by a fire pump, AWWA C900, Class 200 is the minimum acceptable pipe thickness.

A common under ground PVC pipe used is IPEX Blue Brute©. It is manufactured in 4, 5, 8, 10 and 12-inch sizes with couplings and fittings listed for use with the pipe. Couplings and fittings are the same distinctive blue color. The material is manufactured by and sold to companies licensed to produce pipe.

Although AWWA C-900 PVC water pipe is manufactured from a PVC compound with a design basis rating of 4,000 psi for water at 73.4 degrees F., ground temperatures above 75 degrees F. begin to effect the maximum working pressure negatively.

Summer ground temperatures in central and southern Arizona can reach 110 degrees F. These high temperatures reduce the tensile strength of PVC pipe, the result of which is pipe failure.

Pipe is manufactured to cast iron outside diameter size series for use as a pressure conduit in 4, 6, 8, 10 and 12 inch diameters. Wall thickness classes are designated by DR numbers and correspond to pressure classifications: DR-14, Class 200, DR-18, Class 150, and DR-25, Class 100.

Stresses in the wall of an underground pipe around the circumference are called "hoop stresses" and are defined as the circumferential force per unit areas, psi, in the pipe wall due to internal pressure. These stresses are usually given at 73 degrees F. The design engineer must calculate these hoop stresses at the higher temperatures to insure pipe integrity in the summer months.

The following tables show the inside diameters of UL listed and FM Underground Fire Service Approved PVC Pressure Pipe. Included are friction loss factors used instead of calculating the full Hazen-Williams formula, $P = \frac{4.52\,Q^{1.85}}{C^{1.85}\,d^{4.87}}$, use the factor in its place and multiply by the flow to the 1.85 power. So, $\left(\frac{4.52}{C^{1.85}\,d^{4.87}}\right)$ results in an equation reading

$$P = 0.0000000622927\ \mathrm{Q}^{1.85}$$

For example, from the AWWA C900 table for Class 150 six-inch pipe, the factor listed is 6.22927E-08 or 0.0000000622927. Assume a flow of 2200 gallons per minute. The equation would read:

$$P = (0.0000000622927)\ \mathrm{x}\ (1200^{1.85})$$

With a friction loss of .0950 psi per foot of pipe.

Polyvinyl Chloride Pipe Dimensions (Inches) (C-Factor – 150)

Blue Brute® C900 Pressure Pipe Manufactured by J-M MFG CO INC

Class 100 (DR 25) 100 psi | **Class 150 (DR 18) 150 psi** | **Class 200 (DR14) 200 psi**

Nominal Size	Inside Diameter	Friction Loss Factor	Inside Diameter	Friction Loss Factor	Inside Diameter	Friction Loss Factor
4	4.39	3.16641E-07	4.23	3.79395E-07	4.07	4.57767E-07
6	6.30	5.45232E-08	6.09	6.43107E-08	5.86	7.75726E-08
8	8.28	1.44066E-08	7.98	1.72431E-08	7.68	2.07807E-08
10	10.16	5.3186E-09	9.79	6.37174E-09	9.42	7.68673E-09
12	12.08	2.2893E-09	11.65	2.73126E-09	11.20	3.30886E-09

AWWA C900 Specifications for PVC Pressure Pipe (Inches)

Class 100 (DR 25) 100 psi | **Class 150 (DR 18) 150 psi** | **Class 200 (DR14) 200 psi**

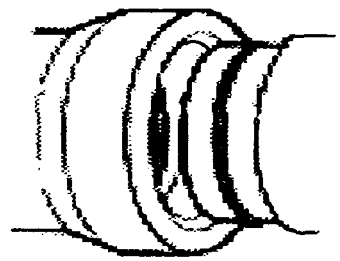
Nominal Size	Inside Diameter	Friction Loss Factor	Inside Diameter	Friction Loss Factor	Inside Diameter	Friction Loss Factor
4	4.42	3.06311E-07	4.27	3.62398E-07	4.11	4.36476E-07
6	6.35	5.24640E-08	6.13	6.22927E-08	5.91	7.44284E-08
8	8.33	1.39903E-08	8.04	1.66254E-08	7.76	1.9758E-08
10	10.21	5.19295E-09	9.87	6.12414E-09	9.51	7.33889E-09
12	12.14	2.23473E-09	11.73	2.64173E-09	11.31	3.15505E-09

NOTE:
Verify type of joint during field inspection.

Push-on (bell and spigot) connections of any type of pipe: NFPA Formal Interpretation.

Gasketed push-on and mechanical joints without special locking devices have limited ability to resist separation due to movement of the pipe. Therefore, all tees, plugs, caps, bends, and hydrant branches having such joints shall be restrained against movement. For the case of welded joints and approved special restrained joints, such as provided by approved mechanical joint retainer glands, locked mechanical and push-on joints, or locking threaded rings, no additional restraint against movement is required. (No thrust blocks).

Illustration of bell and spigot assembly



Joining method for common underground pipe including PVC and cast iron.

(Details of pipe joint may differ from material to material.)

Plastic pipe expands and contracts with temperature changes more than any other type of pipe material. For this reason, gaskets are installed between the pipe sections. Gaskets must be clean and free of debris. The gasket is lubricated as pipe lengths are joined.

Gasketed joints are a major source of leakage. Pipe failure is rare.

NFPA 24
8-9.3.1
AWWA C111

Under AWWA C900, PVC municipal water pipe is tested in the factory at four times its design pressure for five seconds. Field-testing after installation requires a 200-pound test for two hours.

The 200 pound pressure test applicable to the installation of this type of pipe helps seal the gasket. Piping will leak if the sealing surface is not clean, the gasket was not properly lubricated, or if the pipe lengths aren't assembled properly. Once the pipe is properly joined, it can flex at the joint without leakage. Manufacturers limit the flexion to 1.5-2.0 degrees. Manufacturers data must be used to determine the maximum deflection for a particular type or model of pipe.

Ductile iron pipe is classified by thickness; Classes 50, 51, 52, 53, 54, 55, and 56, or by pressure, Standard Pressure Class 150, 200, 250, 300, or 350. Higher pressures are available as high-pressure pipe.

AWWA C104

NFPA 24, 7-2

Ductile Iron Pipe

Ductile iron pipe has superior strength, toughness, impact resistance, and corrosion resistance. For these reasons it is used underground under vehicular traffic, through foundations and under building footprints. The interior of ductile iron pipe used for water service has a cement mortar lining that is centrifugally applied. NFPA

24, 7-2, requires this coating. The pipe is spun and a predetermined amount of cement-mortar slurry is fed into the turning pipe to evenly coat the interior surface. This provides a high degree of interior smoothness and can maintain a C-factor of 140 for many years.

AWWA C105

The exterior of ductile iron pipe is protected from corrosion by a polyurethane coating. The integrity of this coating must be maintained and joints and fittings protected by field coating and wrapping after assembly.

NFPA 24, 8-3.5

Ferrous pipe used for underground water supplies may not be used to ground electrical service in a building. The aboveground sprinkler piping is bonded to the building ground system. Electrical Code Section 250-95 requires a minimum #8 wire bond at the riser if gasketed couplings (Victaulic) are used in the system.

Push-on (bell and spigot) connections of any type of pipe: NFPA Formal Interpretation.

Gasketed push-on and mechanical joints without special locking devices have limited ability to resist separation due to movement of the pipe. Therefore, all tees, plugs, caps, bends, and hydrant branches having such joints shall be restrained against movement. For the case of welded joints and approved special restrained joints, such as provided by approved mechanical joint retainer glands, locked mechanical and push-on joints, or locking threaded rings, no additional restraint against movement is required.

Ductile iron pipe may be joined using several techniques.

Bell (hub) and spigot connections are common as are flanged connections.

Flanged joints are used when pipe is restrained from possible movement of the ground or pipe itself. Pipe flanges are welded or threaded to screw onto the pipe.

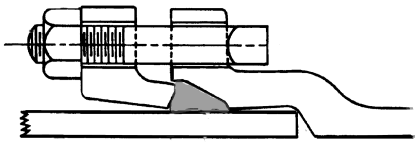
A third type is the restrained joint. Flanges are fitted with collars that are bolted together around the pipe circumference. This mechanically locks two pieces of pipe length together and is used where there is strain on the pipe. Such as under a foundation, under floors or walls, heavy traffic areas, etc.

When using mechanical restraints, the pipe is kept from moving by friction between the pipe and the soil. If all joints in the piping system are not restrained by mechanical means, then thrust blocks must be installed at those joints changing direction.

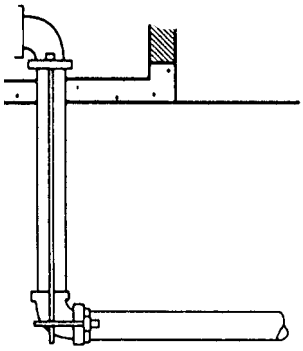
Soil conditions determine the length of pipe surface in contact with a thrust block. Thrust blocks must be designed for each application.

Mechanically restrained joint detail

MECHANICAL JOINT FOR PIPE AND FITTINGS
ANSI/AWWA-CI11/A21.11Standard



The diameter and length of the bolts (high strength, low alloy with hexagonal heads) varies with the size of pipe. When a water supply line changes direction, pipe joints may be attached to another joint by a U-shaped rod through threaded holes on each joint. This restrains pipe from bending laterally or pulling apart at the joints. NFPA 24 requires rodded assemblies when pipe passes under or through foundations.



Rodded pipe assembly to prevent joint from coming apart.

Samples of pipe flanges with restraints

Pipe flanges may be welded or threaded and screwed.

Ductile Iron Pipe Dimensions

Cement-Lined (C-Factor 140)

Nominal Pipe Size	Inside Diameter	Volume Gallons per Linear Foot	Water-filled Weight per Ft.
4	4.17	0.71	18
6	6.27	1.60	31
8	8.42	2.89	48
10	10.45	4.46	67
12	12.51	6.39	92
14	14.55	8.64	119
16	16.61	11.26	151
18	18.69	14.25	185
20	20.75	17.57	225
24	24.95	25.40	305

Minimum residual pressures in underground fire lines connected to municipal water service are limited by health regulations. Residual (flowing) pressures less than 20 psi may result in siphoning. Flow test are expressed as a curve from the static pressure available in the main to 20psi residual pressure.

Velocities in municipal supplies are limited. The maximum velocity is regarded as 10 psi/ft/sec.

Only Schedules 30, 40 and threadable lightwall pipes may be threaded or cut grooved for fittings.

Schedule 10 pipes may not be threaded or cut with grooves. It may be roll-grooved or welded.

New ferrous (steel and wrought iron) pipe has a smoothness (C) factor of 120.

Aboveground Fire Protection Pipe

NFPA 13, 2-3.1

Ferrous (steel) pipe or tube used aboveground in fire protection systems must be listed for fire protection service or must conform with the following standards:

- ASTM A795, (Black or Galvanized Steel Pipe);
- ASTM A53, (Welded and Seamless Steel Pipe);
- ASTM A135, (Elec. Res. Welded Steel Pipe)
- ANSI B36.10M, (Wrought Steel Pipe)

STEEL PIPE DIMENSIONS AND PHYSICAL CHARACTERISTICS (C-FACTOR 120)

Allied Tube & Conduit

XL/BLT Galvanized and black lightwall threadable pipe (ASTM A-135)

Suitable for use in wet, dry, preaction and deluge systems.
Joined with threaded couplings, roll grooved, plain-end couplings, or welded.
XL is galvanized, BLT is black lacquer coated.

XL				BLT		
Size	**Inside diameter**	**Weight with water per linear ft.**		**Size**	**Inside diameter**	**Weight with water per linear ft.**
1	1.104	2.05		1	1.104	1.61
1 ¼	1.452	2.93		1 ¼	1.452	2.93
1 ½	1.687	3.61		1 ½	1.687	3.61
2	2.154	5.13		2	2.154	5.13
2 ½	2.581	6.34				
3	3.200	8.49				

Dyna-flow/Super-Flo Schedule 10 replacement (ASTM A-795 Type E, Grade A)

Suitable for use in wet, dry, preaction and deluge systems.
Joined with roll-groove, plain-end and welded joints.
High strength lightwall steel pipe with black coating

Size	Inside Diameter	Weight with water per linear ft.
1	1.191	1.31
1 ¼	1.536	1.87
1 ½	1.728	2.71
2	2.104	3.79
2 ½	2.703	5.10
3	3.314	7.18
4	4.310	10.86

BULL MOOSE TUBE EDDY Pipe

Eddy Flow
Eddy Flow is listed as a replacement for schedule 10 (ASTM A135 and A795)
FM approved for roll grooving and welding in wet pipe systems.
UL listed for joining by welding or by listed rubber Gasketed fittings for use in wet, dry, preaction and deluge type sprinkler systems. Can be used with roll grooved couplings or welded outlets for pressures up to 175 psi.

Ultra Eddy
Listed as a replacement for Schedule 10 (ASTM A135 and A795)
Designed to Schedule 5 – working pressure to 175 psi.
FM approved fro roll grooving and welding for wet systems.
UL listed for joining by welding or listed rubber Gasketed fittings.
Use for wet, dry, preaction, and deluge systems.

Eddylite
Listed as a replacement for Schedule 40 (ASTM A135 and A795)
Working pressure of 300 psi or less.
Used with standard couplings, fittings and valves.

Eddythread 40
Listed as a replacement for schedule 40 (ASTM A135 and A795)
Working pressure to 300 psi.
Standard schedule 40 threaded fittings and couplings.

Eddy Fast
Listed as a replacement for Schedule 10 (ASTM A135 and A795)
Listed for use with Victaulic FIT fittings in wet systems.
Working pressure of 175 psi.

	Size	1	1 ¼	1 ½	2	2 ½	3	4
Ultra Eddy	I.D.	1.201	1.548	1.786	2.261			
	Water-filled weight	1.359	1.920	2.360	3.344			
	C.R.R.	2.17	1.39	1.11	0.90			
Eddy Flow	I.D.			1.754	2.229	2.729	3.342	4.316
	Water-filled weight			2.657	3.723	5.010	7.082	11.090
	C.R.R.			2.34	1.99	1.09	1.00	1.00
Eddylite	I.D.	1.093	1.438	1.672	2.147			
	Water-filled weight	1.927	2.662	3.268	4.505			
	C.R.R.	0.74	0.48	0.47	0.38			
Eddythread	I.D.	1.090	1.425	1.655	2.124			
	Water-filled weight	2.004	2.830	3.494	4.899			
	C.R.R.	1.00	1.00	1.00	1.00			
Eddy Fast	I.D.		1.514	1.734	2.209			
	C.R.R.		2.93	3.44	2.78			

TEX-Tube Company

Tex-Flow

Listed for wet, dry, preaction and deluge systems (ASTN A795, Grade A, Type E)
Joined by welding or roll-grooved

Size	Inside Diameter
3	3.310
4	4.310
6	6.395

Wheatland Tube Company (New Jersey)

GL Sprinkler Pipe Galvanized Threadable Pipe
UL Listed for wet, dry, preaction, and deluge systems. FM approved for wet systems only.
Joining methods: Threaded couplings, roll grooved or plain-ended couplings, or welded.
ASTM A135, Grade A and ASTM A795 Type E to 300 psi.

Nominal Size	Inside Diameter	Water filled weight linear ft. (lbs/ft)
1	1.103	1.784
1-1/4	1.448	2.475
1-1/2	1.688	3.003
2	2.153	4.264

Mega-Flow lightwall
ASTM A135, Grade A and ASTM A795 Type E, Grade A
UL Listed and FM Approved for grooved and plain-ended fittings.
UL Listed for wet, dry, preaction and deluge systems. FM Approved for wet systems.

Nominal Size	Inside Diameter	Water filled weight linear ft. (lbs/ft)
1-1/4	1.530	1.905
1-1/2	1.740	2.587
2	2.215	3.632
2-1/2	2.707	4.999
3	3.316	7.093
4	4.316	10.674

Mega-Thread Schedule 40 Alternative
ASTM A135, Grade A and ASTM A795
UL Listed for threaded couplings, welded outlets, roll-grooved and plain-end fittings.
UL Listed for wet, dry, pre-action. FM Approved for wet. Hot-dipped galvanized Mega-Thread meets FM for dry systems.
Can be used for earthquake sway bracing and drops.

Nominal Size	Inside Diameter	Water filled weight linear ft. (lbs/ft)
1	1.087	1.864
1-1/4	1.416	2.672
1-1/2	1.650	3.297
2	2.117	4.620

MLT-Black Lightwall Threadable
ASTM A135, Grade A and ASTM A795 Type E for working pressures to 300 psi.
Threaded and welded fittings only.
UL Listed for wet, dry, pre-action, and deluge systems. FM Approved for wet systems.
Use GL Table

All Manufacturers ASTM A135, Grade A

Schedule 10

Nominal Size	Inside Diameter	Water-filled Weight
1	1.097	1.81
1-1/4	1.442	2.52
1-1/2	1.682	3.04
2	2.157	4.22
2-1/2	2.635	5.89
3	3.260	7.94
4	4.260	11.78
5	5.295	17.33
6	6.357	23.03
8	8.249	40.15

Schedule 40

Nominal Size	Inside Diameter	Water-filled Weight
1	1.049	2.05
1-1/4	1.380	2.93
1-1/2	1.610	3.61
2	2.067	5.13
2-1/2	2.469	7.86

Friction loss through fittings for Schedule 40 pipe (from NFPA 13)

Fitting	¾	1	1 ¼	1 ½	2	2 ½	3	3 ½	4	5	6	8	10	12
45° Ell	1	1	1	2	2	3	3	3	4	5	7	9	11	13
90° Ell	2	2	3	4	5	6	7	8	10	12	14	18	22	27
90° Long Ell	1	2	2	2	3	4	5	5	6	8	9	13	16	18
T or Cross	4	5	6	8	10	12	15	17	20	25	30	35	50	60
Gate Valve	-	-	-	-	6	7	10	-	12	9	10	12	19	21
Butterfly Valve	-	-	-	-	1	1	1	1	2	2	3	4	5	6
Check valve	-	5	7	9	11	14	16	19	22	27	32	45	55	65

NFPA 13, 6-4.3

NOTE: **If a manufacturer publishes equivalent loss tables showing different values from the NFPA 13 tables, use the manufacturers' values.**

Although values are listed for Schedule 40 pipe, this table may be used to derive the friction loss per foot of pipe for any pipe type or wall thickness by using the following formula:

$$\left[\frac{\text{Actual inside diameter of pipe}}{\text{Schedule 40 steel pipe inside diameter}}\right]^{4.87} = \text{Factor}$$

Calculation to adjust friction loss in pipes other than Schedule 40.

$$\left[\frac{Actual\ inside\ diameter\ of\ pipe}{Schedule\ 40\ steel\ pipe\ inside\ diameter}\right]^{4.87} = Factor$$

Here is an example of the calculation procedure using 3" Schedule 10 pipe. Inside diameter of 3" Schedule 10 is 3.260. The inside diameter of 3" Schedule 40 pipe is 3.068. Using these values in the formula:

$$\left[\frac{3.260}{3.068}\right]^{4.87} = [1.0626]^{4.87} = 1.3440$$

Multiply the result by the value from the table of equivalent feet for the type of fitting or valve you are using. For this example, use a 3" Tee with a value of 15. A 3" Schedule 10 Tee equivalent loss is:

$$15 \times 1.4559 = 20.1593$$

Round to the nearest .10 to 20.2 feet.

Calculations to adjust friction loss equivalents in pipe other than C=120

The loss table is for pipe with a C-factor of 120. For C-factors other than 120, a multiplier must be used.

To calculate for C-factors other than 120, use the values given in Table 6-4.3.2 and multiply by the equivalent feet. This adjusts the C-factor for values of C other than 120.

NFPA 13 6-4.3

If the value of C is 150, multiply the value from the loss table by 1.51. If the value is 140, multiply by 1.33. This multiplier is applied to the value from the table or calculated as an equivalent pipe length by the process illustrated above.

For the same 3", Schedule 10 pipe with a C-factor of 140, multiply 20.2 by 1.33 for an equivalent pipe length of 26.9 (rounded to nearest tenth.)

COPPER TUBE

NFPA 13, 2-3.4

There are seven types of copper tube covered by ASTM standards.

Copper tube used for fire protection systems must have a wall thickness of Type K, L, or M.

Other wall thickness types are DWV, Medical Gas, ACR, and G tube.
ACR is used for air-conditioning systems and G is used for natural gas and propane.

Copper tube, Types K, L, M, G, DWV and Medical Gas, must be permanently marked (incised) in accordance with its governing specifications to show tube type, the name or trademark of the manufacturer, and the country of origin. In addition to incised markings, hard tube will have this information printed on it in a color that distinguishes its tube type. Soft ACR tube does not carry any incised or color markings. Hard ACR tube is color marked only.

Tables with inside diameters and water capacities per linear foot of pipe appear below. These numbers may be used when verifying hydraulic calculations.

Piping plans of automatic fire sprinkler systems designed for dry pipe service must be provided with the water capacity for the entire system. These tables can be used to verify the quantities of water in copper tube or pipe.

Copper tube has a C-factor of 150.

TYPE K Copper Tube Dimensions and Physical Characteristics

Nominal Size In Inches	Outside Diameter	Inside Diameter	Wall thickness	Cross sectional area of bore, sq. in.	Weight of tube, lbs per linear ft.	Weight of tube and water, lbs per linear ft.	Contents in cubic ft per linear ft.	Contents in gal. Per linear ft.
¾	.750	.652	.049	. 344	.418	.562	.00232	.0174
1	1.125	.995	.065	.778	.839	1.18	.00540	.0404
1 ¼	1.375	1.245	.065	1.22	1.04	1.57	.00847	.0634
1 ½	1.625	1.481	.072	1.72	1.36	2.10	.0119	.0894
2	2.125	1.959	.083	3.01	2.06	3.36	.0209	.156
2 ½	2.625	2.435	.095	4.66	2.93	4.94	.0324	.242
3	3.125	2.907	.109	6.64	4.00	6.87	.0461	.345
3 ½	3.625	3.385	.134	9.00	5.12	9.01	.0625	.468
4	1.125	3.857	.134	11.7	6.51	11.6	.0813	.608

TYPE L Copper Tube Dimensions and Physical Characteristics

Nominal Size in inches	Outside Diameter	Inside Diameter	Wall thickness	Cross sectional area of bore, sq. in.	Weight of tube, lbs per linear ft.	Weight of tube and water, lbs per linear ft.	Contents in cubic ft per linear ft.	Contents in gal. Per linear ft.
¾	.875	.785	.045	.484	.455	.664	.00336	.0251
1	1.125	1.025	.050	.825	.655	1.01	.00573	.0429
1 ¼	1.375	1.265	.055	1.26	.884	1.43	.00875	.0655
1 ½	1.625	1.505	.060	1.78	1.14	1.91	.0124	.0925
2	2.125	1.985	.070	3.09	7.75	3.09	.0215	.161
2 ½	2.625	2.465	.080	4.77	2.48	4.54	.0661	.248
3	3.125	2.945	.090	6.81	3.33	6.27	.0473	.354
3 ½	3.625	3.425	.100	9.21	4.29	8.27	.0640	.478
4	4.125	3.905	.110	11.0	5.38	10.1	.0764	.571

TYPE M Copper Tube Dimensions and Physical Characteristic

Nominal Size in inches	Outside Diameter	Inside Diameter	Wall thickness	Cross sectional area of bore, sq. in.	Weight of tube, lbs per linear ft.	Weight of tube and water, lbs per linear ft.	Contents in cubic ft per linear ft.	Contents in gal. per linear ft.
¾	.875	.811	.032	.517	.328	.551	.00359	.0269
1	1.125	1.055	.035	.874	.465	.843	.00607	.0454
1 ¼	1.375	1.291	.042	1.31	.682	1.25	.00910	.0681
1 ½	1.625	1.527	.049	1.83	.940	1.73	.0127	.0951
2	2.125	2.009	.058	3.17	1.46	2.83	.0220	.165
2 ½	2.625	2.495	.065	4.89	2.03	4.14	.0340	.254
3	3.125	2.981	.072	6.98	2.68	5.70	.0485	.363
3 ½	3.625	3.459	.083	9.40	3.58	7.64	.0653	.488
4	4.125	3.935	.095	12.2	4.66	9.83	.0847	.634

Concealed copper tube installations in Light and Ordinary Hazard Occupancies may be soldered.

NFPA 13, 2-5.4

Copper tube is joined by brazing. Brazing filler materials are melted at temperatures between 1205 and 1550 degrees F. Soldered joints melt at temperatures between 361 and 452 degrees F. Solder joints are allowed for Light and Ordinary Hazard wet pipe systems when the sprinkler heads are of ordinary and intermediate temperatures.

A tool for forming tee connections and outlets in a run of copper can be used in a shop or field assembly.

Metallic-bonded joints by gas-fired torch or electric resistance soldering or brazing may be used.

Grooved-end method of joining pipe is available in a system for copper tube in sizes from 2 through 6 inches. Included are couplings, grooved copper 45- and 90-degree elbows, and straight tees and grooved flange adapters.

NFPA 13, 2-5.5

Other copper tube joining methods may be used if listed for use in fire protection systems.

Equivalent pipe lengths of copper valves and fittings (rounded to the nearest 0.5 ft.)

Nominal size	Fittings					Valves			
	Standard Ell		90° Tee		Coupling	Ball	Gate	Btfly	Check
	90°	45°	Side Branch	Straight Run					
¾	2	.5	3						3
1	2.5	1	4.5			.5			4.5
1 ¼	3	1	5.5	.5	.5	.5			5.5
1 ½	4	1.5	7	.5	.5	.5			6.5
2	5.5	2	9	.5	.5	.5	.5	7.5	9
2 ½	7	2.5	12	.5	.5.		1	10	11.5
3	9	3.5	15	1	1	1.5	1.5	15.5	14.5
3 ½	9	3.5	14	1	1		2		12.5
4	12.5	5	21	1	1		2	16	18.5

BlazeMaster® CPVC pipe may be used only in wet-pipe sprinkler systems.

The BlazeMaster® CPVC products' listing does not include the combination of BlazeMaster® CPVC pipe with other types of CPVC fittings or solvent cements.

BlazeMaster® **CPVC pipe is UL Listed for use in light hazard occupancies, residential occupancies with 13D and 13R systems, air plenums (as defined by NFPA 90A), underground service in accordance with NFPA 24, and system risers in residential buildings up to four stories in height in 13D and 13R systems.**

BlazeMaster® **CPVC pipe is UL listed for use in temperatures not to exceed 150 degrees F**. Locations in unconditioned spaces will approach this temperature in the summer months in the lower deserts of Arizona. Pipe must be protected from these temperatures.

Blazemaster CPVC Pipe Manufactures' Installation Instructions

BlazeMaster® CPVC is the registered trademark for post-chlorinated polyvinyl chloride (CPVC) pipe listed and approved for use in fire sprinkler systems. BF Goodrich holds the patent for the CPVC formula for BlazeMaster® CPVC pipe. In May 2001, BF Goodrich changed their Chemicals Business name to Noveon, Inc. Noveon sells the plastic polymer to four companies granted manufacturing rights. These companies are Harvel Plastics, Hershey Valve Company, IPEX, Ltd., and Tyco Flow Control (Central Sprinkler). Regardless of the manufacturer, the pipe will always be the distinctive orange color and will bear the trade name BlazeMaster® CPVC pipe.

Concealed Installations

With concealed installation the minimum protection shall consist of one layer of 3/8" (9.5 mm) gypsum wallboard, or a suspended membrane ceiling with lay-in panels or tiles having a weight of not less than 0.35 pounds per square foot (1.7 kg per square meter) when installed with metallic support grids, or 1/2" (12.7 mm) plywood soffits. For residential occupancies defined in NFPA 13R and 13D, the minimum protection may consist of one layer of 1/2" (12.7 mm) plywood. During periods of remodeling and renovation, appropriate steps must be taken to protect the piping from fire exposure if the ceiling is temporarily removed.

Exposed Installations Where Sprinklers are Required

Smooth, flat, horizontal ceilings

As an alternative to the protection requirements,

1. BlazeMaster® pipe and fittings may be installed without protection (exposed). An exposed installation is subject to the following additional limitations:
2. Exposed piping is to be installed below a smooth, flat, horizontal ceiling construction.
3. Listed Quick-Response pendent sprinklers having

deflectors installed within 8 inches (203 mm) from the ceiling or Listed Residential pendent sprinklers located in accordance with their Listing and a maximum distance between sprinklers not to exceed 15 feet (4.57 m).

4. Listed Quick Response horizontal sidewall sprinklers having deflectors installed within 6 inches (152 mm) from the ceiling and within 4 inches (101 mm) from the sidewall or Listed Residential horizontal sidewall sprinklers located in accordance with their Listing and a maximum distance between sprinklers not to exceed 14 feet (4.27 m).
5. Exposed pipe employing Listed Quick Response upright heads shall be installed not more than 7-1/2 inches (190 mm) from the ceiling to the centerline of the pipe. Upright heads shall be installed having the deflectors within 4 inches (101 mm) from the ceiling and a maximum distance between sprinklers not to exceed 15 feet (4.57 m). For upright heads, the maximum distance from the centerline of a sprinkler head to a hanger shall be 3 inches (76.2 mm).

When installing BlazeMaster® CPVC pipe and fittings in conjunction with 2 in. x 12 in. solid wood joists, the maximum system working pressure under flowing conditions shall not exceed 100 psi and the maximum system working pressure under static (non-flowing) conditions shall not exceed 175 psi.

Unfinished Basements

BlazeMaster® CPVC pipe and fittings may be installed without protection (exposed) in unfinished basements in accordance with NFPA 13D subject to the following additional limitations:

1. The ceiling shall be horizontal and constructed utilizing nominal 2 in. x 10 in. solid wood joists on 16 in. centers.

OR

The ceiling shall be horizontal and constructed utilizing nominal 2 in. x 12 in. solid wood joists on 16 in. centers.

2. The distance from the floor to the bottom of the solid wood joists shall be between 7 ft. and 8 ft.
3. Listed residential pendent sprinklers with a maximum temperature rating of 155°F and a minimum K-factor of 3.0 are to be used for this type of installation. The maximum sprinkler spacing shall not exceed 12 feet. The system is to be designed based upon the Listed flows for the sprinkler selected except that the flow for a single sprinkler flowing is to be not less than 10 gpm and the flow for multiple sprinklers flowing is to be not less than 8 gpm per sprinkler. The sprinklers are to be installed with their deflectors a maximum of 1-3/4 in. below the bottom of the solid wood joists in anticipation of future installation of a finished ceiling.
4. All system mains shall be run perpendicular to the joists. All branch lines shall be run parallel to the joists.
5. All solvent cement joints shall be made with BlazeMaster® One Step Solvent Cement (CSC-400, CSC-500, FS-5, BM-5).

NFPA 13D, 4-2.4

6. When the total protected area exceeds 1,000 square feet, blocking shall be utilized to divide the area into individual compartments not exceeding 1,000 square feet. The maximum length along the joist shall not exceed 32 feet. When the length exceeds 32 feet, blocking shall be utilized. The blocking shall be constructed of minimum 1/2 in. plywood and shall be the full depth of the wood joists.

It is acceptable for items such as piping, wires, ducts, etc. to penetrate the blocking. The gap between the item penetrating the blocking and the blocking should be minimized. For installations where the gap exceeds 1/4 in., the gap shall be filled with insulation, caulking, or other suitable material.
NOTE: Materials used to fill the gap must be listed for use with BlazeMaster ® CPVC pipe.

7. When installing BlazeMaster® CPVC pipe and fittings

perpendicular (system mains) to the solid wood joists, listed support devices for thermoplastic sprinkler piping or other listed support devices shall be used which mount the piping directly to the bottom of the solid wood joists. As an alternative to mounting the pipe and fittings below the solid wood joists, it is also acceptable to cut holes in the solid wood joists at or below the center of the depth of the solid wood joist for support - the holes should be oversized to allow for movement and located to not impair the structural integrity of the joists.

8. When installing BlazeMaster® CPVC pipe and fittings parallel (branch lines) to the solid wood joists, the pipe and fittings shall be installed in the cavity below the bottom of the ceiling and above the bottom of the joist. The branch lines shall be located at or below the center of the depth of the solid wood joist. The pipe shall be installed utilizing listed support devices for thermoplastic sprinkler piping or other listed support devices which mount the piping directly to nominal 2 in. wood blocking or listed support devices for thermoplastic sprinkler piping which offset the pipe a nominal distance of 1-1/2 in. from the solid wood joists.

Use of BlazeMaster CPVC pipe and fittings is limited to basements where the quantity and combustibility of contents is low and fires with relatively low rates of heat release are expected.

Factory Mutual

Factory Mutual (FM) approval requires the pipe to be protected by a permanent non-removable fire resistant barrier. Exposed pipe and drop in ceiling panels are not acceptable.

Sprinkler Head Temperature Ratings

BlazeMaster® pipe and fittings shall be used in sprinkler systems employing sprinkler heads rated 170°F (77°C) or lower, for pendent and horizontal sidewall heads. Quick-

Response upright heads shall be rated at 155°F (68°C) or less.

Temperature/ Pressure Rating

BlazeMaster® pipe and fittings (3/4" – 3") are rated for continuous service of 175 psi (1207 kPa) at 150°F.

BlazeMaster® pipe and fittings are suitable for use in areas where ambient temperatures are within the range of 35°F to 150°F. BlazeMaster® pipe can be installed in an area, such as an attic, where the temperature will exceed 150°F if ventilation is provided or if insulation is used around the pipe to maintain a cooler environment.

BlazeMaster® piping systems must be laid out so that the piping is not closely exposed to devices that generate heat in excess of 150°F such as light fixtures, ballasts and steam lines.

If the installation is in an area subject to freezing temperatures, the sprinkler system must be protected from freezing. A frozen system will not only be deactivated, but the pressures that may build up can cause the sprinkler heads to open or damage the pipes.

Central Sprinkler Model CC-1 Combustible Concealed Space Sprinklers™ are the only sprinklers listed for use in concealed spaces with BlazeMaster® CPVC pipe.

NFPA 13R and 13D permit the omission of sprinklers from combustible concealed spaces and BlazeMaster® pipe and fittings may be installed in these areas when sprinklering residential occupancies according to these standards.

Combustible Concealed Installations

BlazeMaster® pipe and fittings must never be installed in combustible concealed spaces requiring sprinklers, as referenced in NFPA 13. EXCEPTION: Specially listed sprinkler heads exist that have been tested and are listed for use with BlazeMaster® products in combustible concealed spaces requiring sprinklers. When using BlazeMaster® products in these applications always follow the sprinkler head manufacturers' installation guidelines.

Note: BlazeMaster® pipe and fittings may be installed in the

Air Plenums

BlazeMaster® pipe and fittings are approved for use in air

plenum adjacent to, but not over, an opening in the ceiling such as ventilation grills.

plenums. BlazeMaster® pipe and fittings have been investigated by UL per the requirements of UL 1887 and found to comply with the combustibility requirements for thermoplastic sprinkler pipe as described in the Standard for Installation of Air Conditioning and Ventilating Systems, NFPA 90A and various model mechanical codes.

Ordinary Hazard Installation NFPA 13, 3-3.5

The use of pipe or tube listed for light hazard occupancies to be installed in ordinary hazard rooms of otherwise light hazard occupancies where the room does not exceed 400 sq. ft. is permitted. BlazeMaster® CPVC pipe and fittings can be installed in these installations in accordance with the manufacturer's installation instructions.

Garage Installations

When installed concealed, BlazeMaster® CPVC pipe and fittings may be used to protect 13R garages per the following requirements:

1. Minimum protection shall consist of either one layer of 3/8" thick gypsum or 1/2" thick plywood.
2. Listed pendent or sidewall sprinklers with a maximum temperature rating of 170°F shall be utilized. All sprinklers shall be installed per the manufacturer's published installation instructions.
3. The system shall be installed per the requirements of NFPA 13R.
4. The BlazeMaster® CPVC sprinkler pipe and fittings shall be installed per the manufacturer's installation instructions.

NOTE: NFPA 13D, Section 4-6 (1999 Edition), Exception Number 3 states: "Sprinklers shall not be required in garages, open attached porches, carports, and similar structures". Since sprinklers are not required in NFPA 13D garages, these installations do not fall within the scope of the Listing. However, BlazeMaster® CPVC pipe and fittings may be installed in NFPA 13D garages.

System Risers in NFPA 13R and 13D Applications

BlazeMaster® CPVC pipe and fittings may be used as system risers in accordance with NFPA 13D and 13R with the following limitations:

1. When installed protected (concealed), the minimum protection shall consist of either one layer of 3/8 in. (9.5 mm) thick gypsum wallboard or 1/2 in. (12.7 mm) thick plywood.

2. When installed without protection (exposed), the following limitations shall apply:

    a) The riser shall be installed below a smooth, flat, horizontal ceiling construction. A Listed residential pendent sprinkler is to be installed with its deflector at the distance from the ceiling specified in the sprinkler Listing. OR The riser shall be installed below a horizontal unfinished basement ceiling (in accordance with NFPA 13D) constructed utilizing nominal 2 in. x 10 in. or nominal 2 in. x 12 in. exposed solid wood joists on 16 in. centers. A Listed residential pendent sprinkler is to be installed with its deflector a maximum of 1-3/4 in. below the bottom of the solid wood joist in anticipation of future installation of a finished ceiling.

    b) A Listed residential pendent sprinkler is to have a maximum temperature rating of 155°F and a minimum K-factor of 3.0 to be installed at a maximum horizontal distance of 12 inches from the centerline of the riser. The system is to be designed based upon the Listed flows for the sprinkler selected except that the flow for a single sprinkler flowing is to be not less than 10 gpm and the flow for multiple sprinklers flowing is to be not less than 8 gpm per

sprinkler.

c) The riser shall be supported vertically within 2 feet of the ceiling or bottom of the joist.
d) The minimum riser diameter shall be 1 in. and the maximum riser diameter shall be 2 in.
e) The maximum distance between the wall(s) and the outside surface of the riser pipe shall be 1-1/2 in.
f) All solvent cement joints shall be made with BlazeMaster® One Step Solvent Cement (CSC-500, FS-5, or BM-5).
g) Access doors to system risers must have a clear opening of 36 inches by 36 inches. All devices must be accessible from the opening.

3. The system shall be installed per the requirements of NFPA 13, Sections 6-2.5 (1999 Edition), Support of Risers.

4. The BlazeMaster® CPVC sprinkler pipe and fittings shall be installed per the manufacturer's installation instructions.

5. Risers shall be supported by pipe clamps or by hangers located on the horizontal connection close to the riser. Only Listed hangers and clamps shall be used.

6. Vertical lines must be supported at intervals, described in 7 & 8 below, to avoid placing excessive load on a fitting at the lower end. Do this by using riser clamps or double bolt pipe clamps Listed or approved by the manufacturer for this service. The clamps must not exert compressive stresses on the pipe. If possible, the clamps

should be located just below a fitting so that the shoulder of the fitting rests against the clamp. If necessary, a coupling can be modified and adhered to the pipe as a bearing support such that the shoulder of the fitting rests on the clamp.

7. Riser clamps that squeeze the pipe and depend on compression of the pipe to support the weight are not allowed.

8. Hangers and straps shall not compress, distort, cut or abrade the piping and shall allow for free movement of the pipe to allow for thermal expansion and contraction.

9. Maintain vertical piping in straight alignment with supports at each floor level, or at 10 feet intervals, whichever is less.
10. CPVC risers in vertical shafts or in buildings with ceilings over 25 feet, shall be aligned straightly and supported at each floor level, or at 10 feet intervals, whichever is less. (Observe limitations of temperature. Riser materials must be suitable for the ambient temperature encountered.)

Maximum Support Spacing Distance In Line (Ft.)
Sprinkler Head on a Drop Tee

Pipe Size	Less than 100 psi	More than 100 psi
¾"	4'	3'
1"	5'	4'
1 ¼"	6'	5'
1 ½ "-3"	7'	7'

Maximum Support Spacing Distance End Line (Ft.)
Sprinkler Head on an Elbow

Pipe Size	Less than 100 psi	More than 100 psi
¾"	9'	6'
1"	12'	9'
1 ¼"	16'	12'
1 ½ "-3"	24'	12'

Hangers at the end of a line must also brace a pendent head from vertical uplift when sprinkler discharges.