

PLUMBING SEMINAR

Domestic Water Systems

Prepared by Russ Meier

June 3, 1995

Reference specification Section 15410, 15430 & 15450

Domestic Water Systems:

1. Determine the total demand for water in the building for both potable and nonpotable uses. This can be done using various methods ranging from a preliminary square foot estimate based on building usage to a detailed fixture count. Each building should have a detailed fixture count included in the design file prior to checking. A computerized form is available to calculate the total fixture units required. Once the fixture units are determined then Refer to the Hunter curves to determine the flowrate in gallons per minute (GPM).
2. Water service to a building should be in Type K copper for pipes 2" and smaller and cast iron pipe with cement liner for larger pipes. KJWW typically designs from 5' outside the building foundation so coordinate piping material and location with utility or site engineer. All pipes should have a minimum of 42" of cover to protect them from freezing. Verify exact depth with local code official.
3. Domestic water will usually splits into two services one for fire protection and one for the potable water systems. Most areas require a backflow preventor on each system. Review with local code official.
4. Water meters are usually provided by the utility providing the water. Review this with the utility company and determine the type of water meter will be provided.
5. Determine the available water pressure by contacting the utility or conducting flow tests. If the pipe connection under design is within one pipe size of the main, the new demand on the pipe may reduce the available water pressure.

Use the Hunter curves to determine the design flow rate required in GPM. Then see the guide for evaluating fire protection mains for the new main pressure to be used.

Contact the utility company and inform them of the additional load. They may also assist with calculations and advise on any other requirements.

6. Once the design flow rate and the available pressure have been determined the

actual pipe sizing can be completed. The following steps must be followed. A standard form is available and should be completed and filed in the design file.

- a. Determine the pressure in the domestic water line serving the building in PSI.
- b. Determine the pressure required at the plumbing fixtures served by the domestic water system. The largest pressure required to operate a fixture installed in the building is the residual pressure that the entire system must be able to provide.

Typical values for residual pressures are:

Plumbing Fixtures with tanks	20-25 PSI
Plumbing Fixture with Flush Valve	25-30 PSI
Circular wash station	30 PSI

- c. Determine the pressure drop through the water meter.
- d. Determine the pressure drop through the backflow prevention device.
- f. Calculate the pressure available on standard form. See example below.

Pressure at water main	82 PSI
Water meter pressure drop	-8 PSI
Backflow Prevention Device pressure drop	-15 PSI
Minimum required residual pressure	-25 PSI
Elevation difference	9ft x .433 PSI/ft =
	<u>- 4 PSI</u>
	30 PSI

30 PSI is available for distribution losses in the piping system.

- g. Determine the length of pipe to the most remote fixture and multiply by a factor of 1.6 for copper pipe and 1.75 for steel pipe to estimate fitting losses in the piping system.

$$1000 \text{ ft} \times 1.6 = 1600 \text{ equivalent ft}$$

- h. The maximum friction rate allowable for the system is the available pressure (from f.) divided by the equivalent length of the system (from g.).

$$30 \text{ PSI} / 1600 \text{ ft} = 0.019 \text{ PSI} / 100 \text{ ft}$$

It is common to express pressure drop in pipes in PSI/100 ft.

$$30 \text{ PSI} \times 100 / 1600 \text{ ft} = 1.9 \text{ PSI} / 100 \text{ ft}$$

- i. With the maximum friction rate allowable determined the designer can develop a sizing table for fixture unit for pipe size. Note that systems with flush valves require larger pipes than systems without.

Velocity in pipes greater than 10 FPS has the potential to generate noise and erode pipes. Keep velocities in pipes between 8 FPS and 4 FPS if possible.

- J. Since hot water is not usually connected to flush valves it is possible to use the nonflush valve pipe sizes.

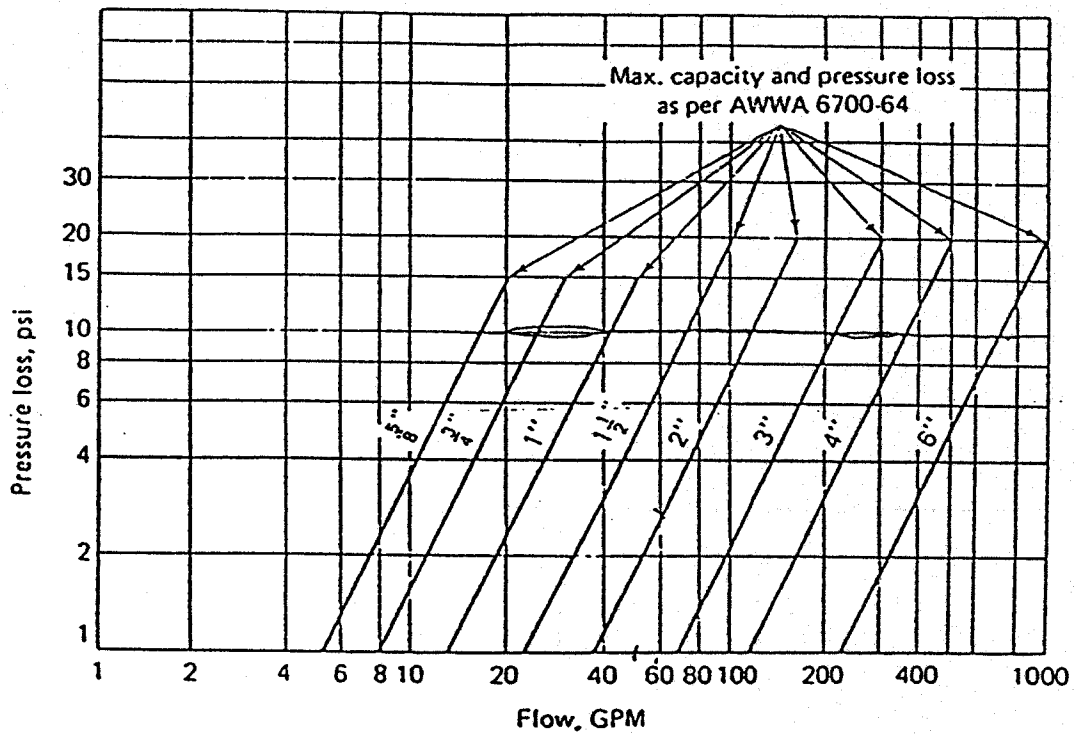
Determine the maximum water pressure drop through the water heater for design conditions.

$$\text{HW residual pressure} = \text{CW residual pressure} - \text{Water Heater P.D.}$$

It is important that the hot and cold water supply pressures are within 15% to insure proper operation of mixing valves and other fixtures. If the residual hot water pressure divided by the residual cold water pressure is less than 15% the pipe sizes for the hot water system should be calculated separately.

Determine the pressure drop up to the water heater and use the standard form including the water heater pressure drop in lieu of the water meter.

- K. Large or critical hot water systems are recirculated to maintain water temperature. The design procedure is discussed in another seminar.



Pressure Loss in Cold-Water Meters of the Displacement Type

Series 909

Sizes 3/4" - 2"

"Engineered for high capacity relief"

To prevent back-siphonage and backpressure of contaminated water into the safe drinking water supply, when installed at each high hazard cross-connection.

Use Series 909 for backflow protection in cross-connection control and containment at the service entrance. The 909 high capacity relief incorporates the "air-in/water-out" principle and substantially improves the relief valves discharge performance. The emergency condition of combined back-siphonage and backpressure with both checks fouled can defeat the effectiveness of a standard RPZ backflow preventer. Standardly furnished with NPT body connections and quarter-turn, full port, resilient seated, bronze ball valve shut-offs No. 909QT. Sizes 3/4" and 1" have Tee handle shut-offs.

Available Models

Prefix

C - with strainer clean and check, 3/4" and 1" only

Suffix

QT - with quarter -turn, full port, resilient seated ball valve shut-offs

S - with bronze strainer

HW - with stainless steel check modules for hot water and harsh water conditions

PC - with internal Polymer Coating

LF - without shut-off valves

Prefix

U - with integral body unions (3/4" and 1" only)

FAE - with flanged adapter ends (1/4", 1/2", 2" only)

Features

- Quarter-turn ball valve shut offs
- Replaceable bronze seats
- Designed pressure drop
- Simple and economical service
- High capacity relief protection against combined back-siphonage/backpressure backflow
- Modular design
- No special tools required for servicing

Standards (see page 3)

Pressure-Temperature

Series 909 suitable for supply pressure up to 175 psi and water temperatures up to 140°F continuous and 180°F intermittent. Suffix HW stainless steel check modules suitable for supply pressure up to 175 psi and water temperature up to 210°F for harsh water conditions.

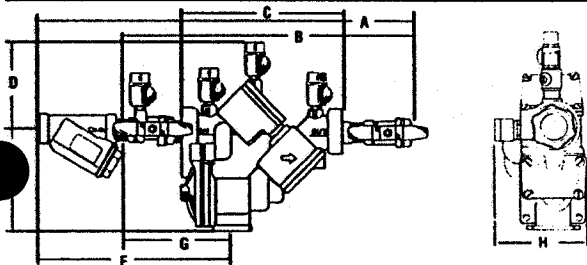
Connections

3/4" - 1" 909QT has NPT female threaded body connections.

1/4" - 2" 909QTM1 has NPT male threaded body connections.

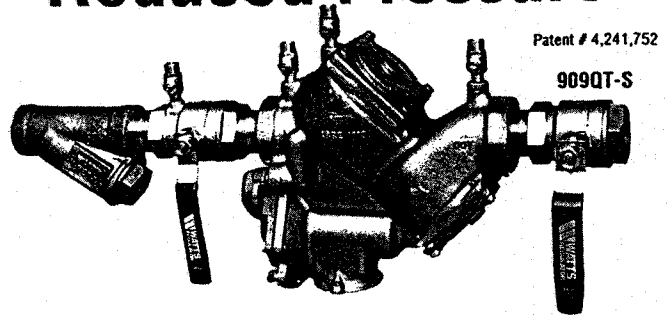
Dimensions-Weights (approximate)

Size (inches)	Dimension (inches)								Wgt. (lbs.)	
	A	B	C	D	E	F	G	H	w/o strainer	
3/4	21 1/4	17 1/4	7 3/16	4	4 3/4	11 1/4	6 3/4	3 3/4	15%	14
1	22 1/4	17 3/16	7 3/16	4	4 3/4	13	7	3 3/4	17 1/2	15
1 1/4	25 3/4	20 3/4	10 3/4	5	6 1/4	14	7 1/2	5 1/4	42 3/4	40
1 1/2	27 3/16	21 3/4	10 3/4	5	6 3/4	15	7 3/4	5 1/4	44	40
2	30 3/4	23 3/4	10 3/4	5	6 3/4	16	7 3/4	5 1/4	47 3/4	40



For more information, send for ES-909S

Reduced Pressure Zone



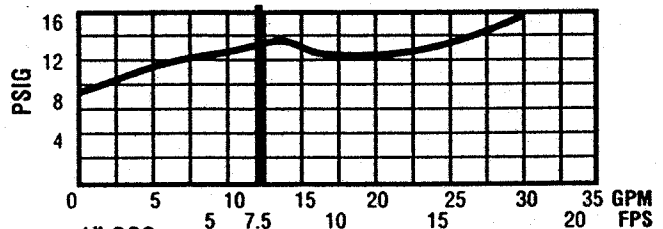
Note: The installation of a drain line recommended. When installing a drain line, and air gap is necessary (see page 5).

BACKFLOW PREVENTION FOR HIGH HAZARD CROSS-CONNECTION and CONTAINMENT INSTALLATIONS WITH CONTINUOUS PRESSURE Capacity

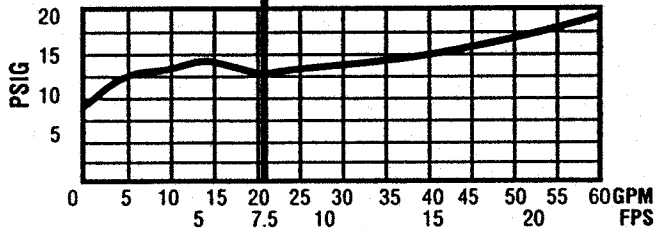
As compiled from documented Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California lab tests.

*Typical maximum mechanical/irrigation system flow rate (7.5 feet per second)

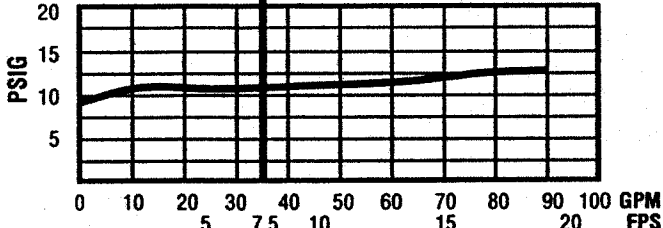
3/4" 909



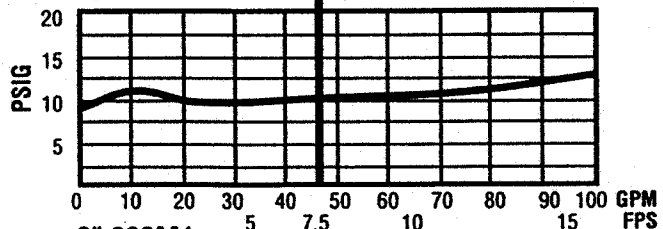
1" 909



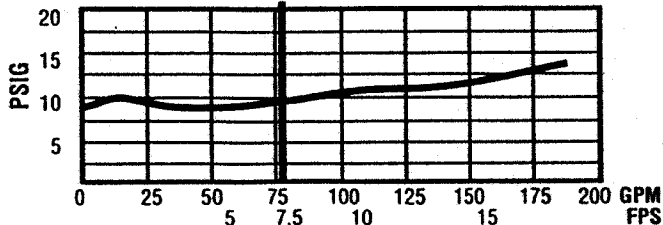
1 1/4" 909



1 1/2" 909M1



2" 909M1



Backflow Preventers

Series 909

Sizes 2½" - 10"

Series 909 2½" - 10" provide backflow protection in cross-connection control and containment with its unique patented design incorporating the "air-in/water-out" principle.

Available Models

Suffix

NRS - with non-rising stem resilient seated gate valves

S-FDA - with FDA approved epoxy coated strainer

BB - with bronze body (2½", 3")

OSY - with UL/FM resilient seated outside stem and yoke gate valves

QT - with quarter-turn, full port, resilient seated ball valve shut-offs

QT-FDA - with FDA approved epoxy coated ball valve shut-offs

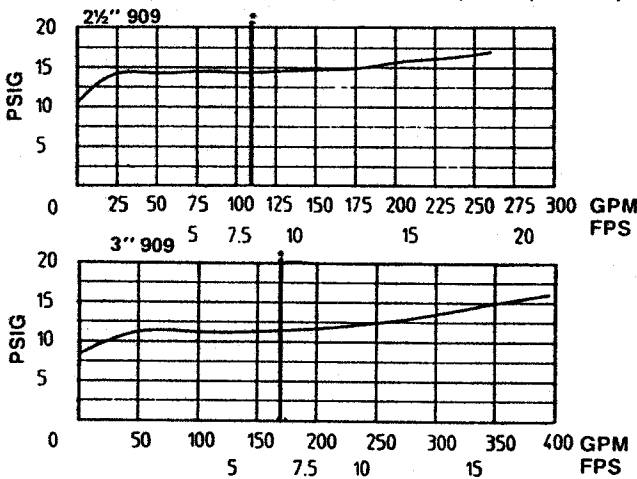
LF - without shut-offs

Note: The installation of a drain line is recommended. When installing a drain line, an air gap is necessary (see page 5).

Capacity

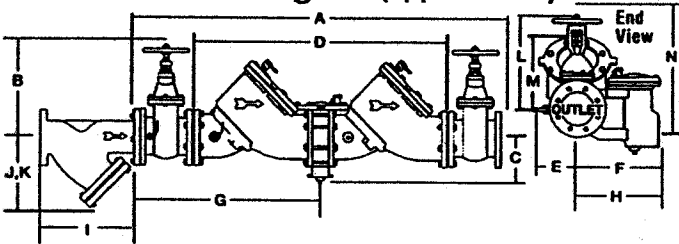
As compiled from documented Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California lab tests.

*Typical maximum mechanical/irrigation system flow rate (7.5 feet per second)



Note: Relief valve section is reversible, therefore, dimension "F" can be either side. Standardly furnished as shown. Specify RH if relief valve is to be supplied on the opposite side from standard.

Dimensions-Weights (approximate)

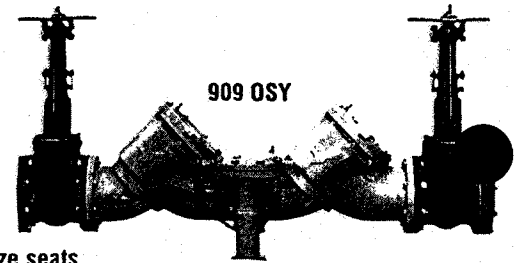


Size	Dimensions (Inches)																Weight (lbs.)		
	A	B				C	D	E	F	G	H	I	*J	K	*L	*M	*N	NRS	OS&Y*
2½"	41¼	11¾	15¾	7	5¼	26¾	4	9¼	20¾	7¾	10	10	6½	14	11	20	195	198	182
3"	42¼	12¼	18½	7	5¼	26¾	5	9¼	21¼	7¾	10½	10	7	14	11	20	225	230	190
4"	55	15¾	23¼	10	6	37	6	14¾	27¾	12½	12½	12	8¼	17	14	25	455	470	352
6"	65½	19¾	32½	15	6	44½	11	14¾	32¾	12½	18½	20	13½	21	16	34	718	798	750
8"M1	78¼	24½	39¼	19	9¾	55¼	11¼	19¼	39¾	17¾	21¾	22¼	15½	26	21	41	1,350	1,456	2,230
10"M1	93¾	29¼	48	22	9¾	67¾	12½	21	46¾	19¾	26	28	18½	32	21	52	2,160	2,230	3116

*J, L, M, N dimension are clearance required for servicing (in inches).

For more information, send for ES-909L

Inquire with governing authorities for local requirements



Features

- Replaceable bronze seats
- Resilient seated gate valve shut-offs
- No special tools required for servicing
- Watts Banner Blue™; NSF 61 listed - FDA approved epoxy coated

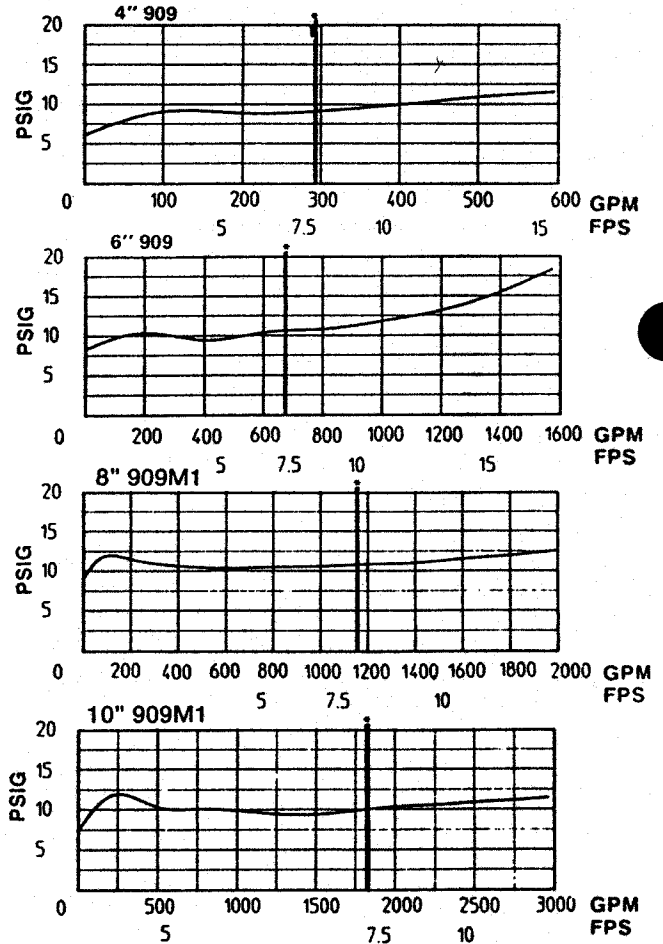
Standards (see page 3)

Pressure-Temperature

Suitable for supply pressure up to 175 psi and water temperatures up to 110°F continuous and 140°F intermittent.

Materials

Watts Banner Blue™; NSF 61 listed - FDA approved epoxy coated cast iron check valve bodies with bronze check seats and stainless steel relief valve seat.



DOMESTIC WATER SIZING FORM

PROJECT #: _____
 PROJ. NAME: _____
 DESIGNER: _____
 DATE: _____

- _____ PRESSURE AT POINT OF CONNECTION TO CITY WATER SYSTEM (PSIG)
- _____ PRESSURE DROP DUE TO ELEVATION CHANGE (0.433 PSI/FOOT)
- _____ WATER METER PRESSURE DROP (FROM CHART OR ASSUME 5 PSI)
- _____ RESIDUAL PRESSURE REQUIRED AT CRITICAL FIXTURE **(30 PSI)**

= _____ PRESSURE AVAILABLE FOR PIPE SYSTEM LOSSES (PSI)

_____ ESTIMATED LENGTH OF PIPING FROM TAP TO MOST REMOTE OUTLET.
 x _____ EQUIVALENT LENGTH FACTOR ACCOUNTS FOR FITTINGS AND CORROSION. (1.6 FOR COPPER PIPE AND 1.75 FOR STEEL PIPE)

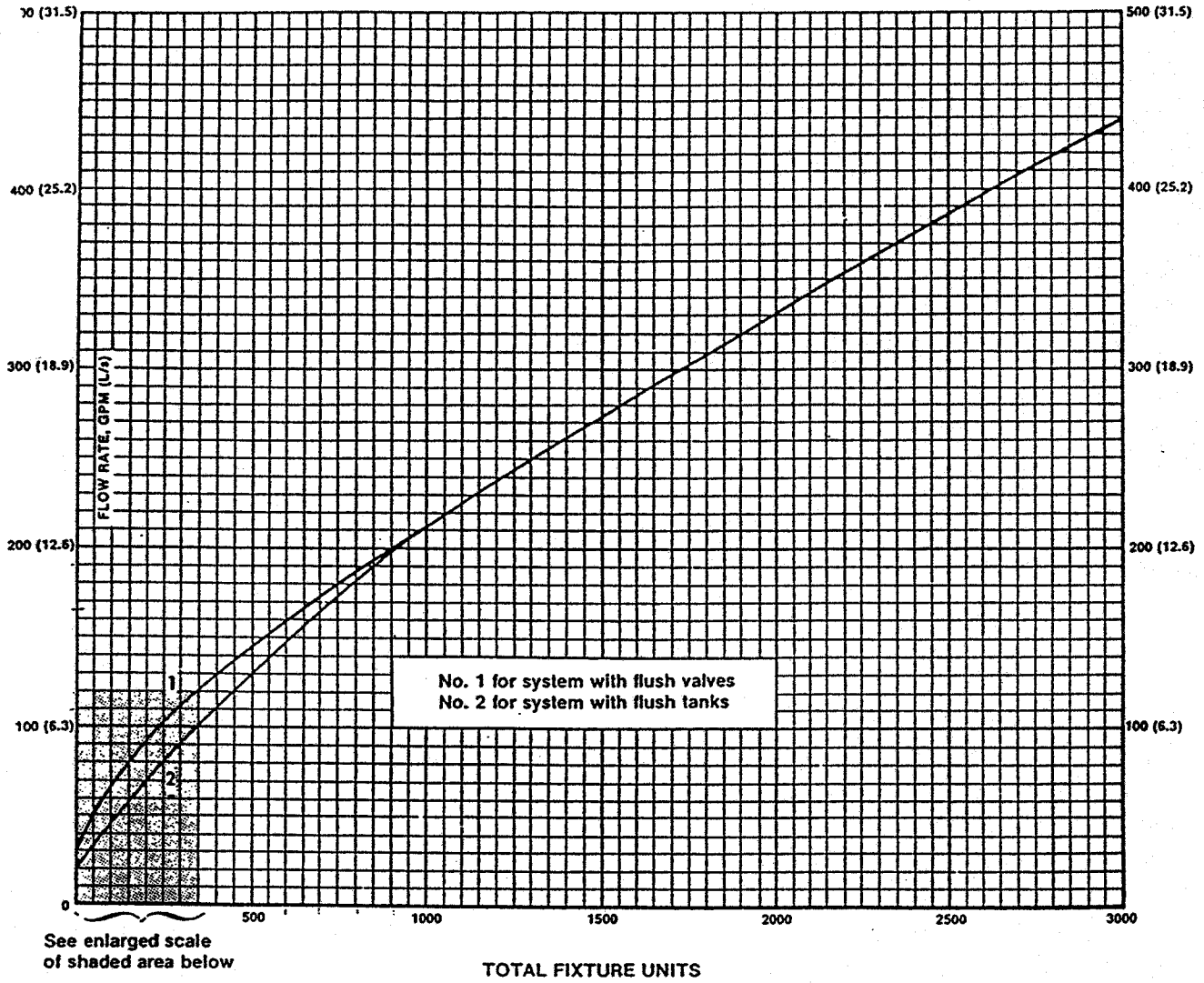
= _____ EQUIVALENT LENGTH (FEET)

_____ MAXIMUM ALLOWABLE FRICTION FACTOR (PSI PER 100 FT)
 (AVAILABLE PRESSURE x 100 / EQUIVALENT LENGTH)

_____ DESIGN FRICTION RATE - Fr (PSI/100FT)
 (DESIGNER'S JUDGEMENT BASED ON TYPE OF BUILDING, ETC.)

SIZE PIPE WITHIN THE DESIGN FRICTION RATE AND LIMIT VELOCITY TO 4FPS IN 3/4" AND SMALLER PIPES AND 8FPS IN LARGER PIPES TO LIMIT NOISE. SIZING IN THE SHADED AREA IS LIMITED BY VELOCITY.

PSI/100FT	2.0	4.0	6.0	
SIZE	LOW	MED	HIGH	SPECIAL NOTES
1/2"	1.4	2.1	2.6	COPPER PIPE (C=130)
3/4"	4	6	7	COPPER PIPE (C=130)
1"	8	12	15	COPPER PIPE (C=130)
1-1/4"	14	20	25	COPPER PIPE (C=130)
1-1/2"	22	32	40	COPPER PIPE (C=130)
2"	46	70	75	COPPER PIPE (C=130)
2-1/2"	68	92	120	GALVANIZED STEEL PIPE (C=100)
3"	102	150	170	GALVANIZED STEEL PIPE (C=100)
4"	220	315	320	GALVANIZED STEEL PIPE (C=100)
5"	380	480	480	GALVANIZED STEEL PIPE (C=100)
6"	610	700	700	GALVANIZED STEEL PIPE (C=100)
8"	1250	1250	1250	GALVANIZED STEEL PIPE (C=100)
10"	1900	1900	1900	GALVANIZED STEEL PIPE (C=100)
12"	2700	2700	2700	GALVANIZED STEEL PIPE (C=100)



ENLARGED SCALE

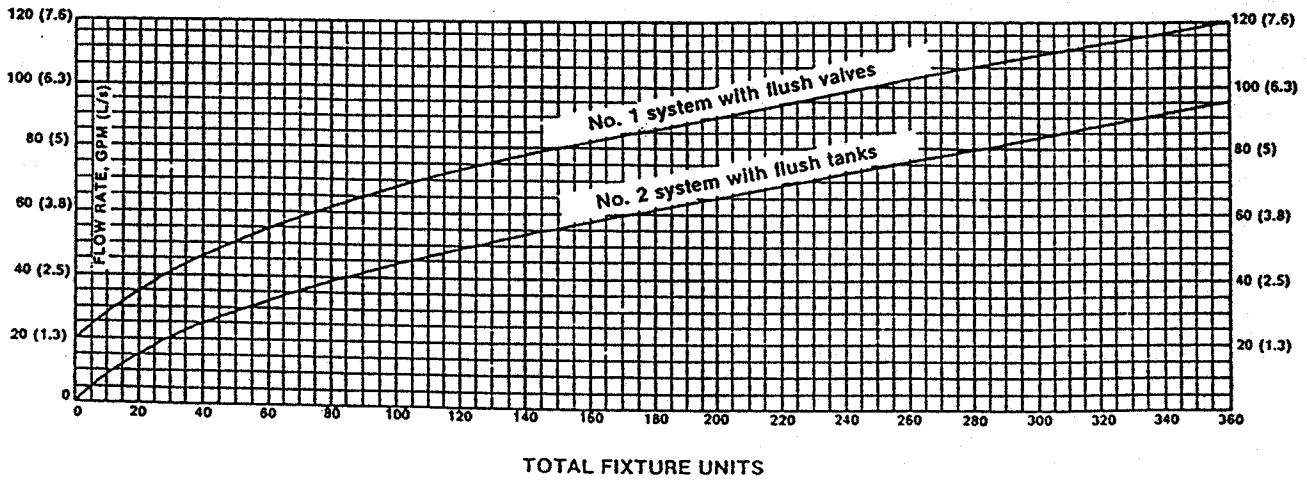


Figure 3-2. Conversion of fixture units to GPM (L/s).

DOMESTIC WATER PIPING

FIXTURE UNITS

SIZE	5 PSI/100		2 PSI/100		1 PSI/100		0.5 PSI/100	
	NFV	FV	NFV	FV	NFV	FV	NFV	FV
1/2"	2	--	1	--	1	--	1	--
3/4"	6	--	4	--	2	--	2	--
1"	15	10	10	5	5	5	5	5
1-1/4"	30	10	22	10	15	10	7	5
1-1/2"	50	15	35	10	20	10	12	10
2"	220	105	100	35	65	20	30	10
2-1/2"	500	350	300	145	120	45	80	25
3"	900	900	600	500	350	200	195	85
4"	2650	2650	1500	1500	900	900	600	500
6"	6000	6000	6000	6000	4200	4200	2200	2200

NFV = NON-FLUSH VALVE

FV = FLUSH VALVE

Section 890.0-Appendix A PLUMBING MATERIALS, EQUIPMENT, USE
RESTRICTIONS AND APPLICABLE STANDARDS

Section 890.0-Appendix A PLUMBING MATERIALS, EQUIPMENT, USE
RESTRICTIONS AND APPLICABLE STANDARDS

Table N Water Supply Fixture Units (W.S.F.U.) for a Supply System
with Flush Tanks (Continued)

Table N Water Supply Fixture Units (W.S.F.U.) for a Supply System
with Flush Tanks

Water Supply Fixture Units (W.S.F.U.) for a
Supply System with Flush Tanks (Continued)

Water Supply Fixture Units (W.S.F.U.) for a
Supply System with Flush Tanks

W.S.F.U.	Demand (GPM)	Pipe Size (Inches)	Pressure Loss (PSI/100' of Pipe)	Velocity (Ft./Sec.)	Meter Size (Inches)
500	125	3"	2.3	5.9	3"
600	145	3"	3.1	6.8	4"
750	170	3"	4.0	8.0	4"
1000	208	4"	1.5	5.7	4"
1250	240	4"	1.9	6.4	4"
1500	267	4"	2.3	7.0	4"
1750	294	4"	2.8	7.8	4"
2000	320	6"	0.36	3.7	6"

W.S.F.U.	Demand (GPM)	Pipe Size (Inches)	Pressure Loss (PSI/100' of Pipe)	Velocity (Ft./Sec.)	Meter Size (Inches)
2	2	1/2"	4.2	2.7	5/8"
4	3	1/2"	8.7	4.2	5/8"
6	5	1/2"	22.5	7.0	5/8"
8	6.5	3/4"	6.3	4.3	5/8"
10	8	3/4"	9.0	5.4	3/4"
12	9.2	3/4"	11.5	6.1	3/4"
14	10.4	3/4"	15.0	6.9	3/4"
16	11.6	3/4"	18.0	7.7	3/4"
20	14	1"	7.2	5.6	3/4"
25	17	1"	10.0	6.6	3/4"
30	20	1"	13.6	8.0	1"
35	22.5	1 1/4"	5.8	5.7	1"
40	25	1 1/4"	7.0	6.3	1"
45	27	1 1/4"	8.2	6.9	1"
50	29	1 1/4"	9.5	7.4	1"
60	32	1 1/2"	5.0	5.8	1 1/2"
70	35	1 1/2"	6.2	6.4	1 1/2"
80	38	1 1/2"	7.0	7.2	1 1/2"
90	41	1 1/2"	8.0	7.5	1 1/2"
100	43.5	1 1/2"	8.7	7.8	2"
120	48	2"	2.7	5.0	2"
140	52.5	2"	3.1	5.4	2"
160	57	2"	3.6	5.8	2"
180	61	2"	3.9	6.1	2"
200	65	2"	4.5	6.6	2"
225	70	2"	5.2	7.1	2"
250	75	2"	6.0	7.7	3"
275	80	2 1/2"	2.6	5.5	3"
300	85	2 1/2"	2.9	5.8	3"
350	95	2 1/2"	3.5	6.5	3"
400	105	2 1/2"	4.2	7.1	3"
450	115	2 1/2"	5.0	8.0	3"

Section 890. Appendix A PLUMBING MATERIALS, EQUIPMENT, USE RESTRICTIONS AND APPLICABLE STANDARDS

Table O Water Supply Fixture Units (W.S.F.U.) for a Supply System with Flushometer (Continued)

Water Supply Fixture Units (W.S.F.U.) for a Supply System with Flushometer (Continued)						
W.S.F.U.	Demand (GPM)	Pipe Size (Inches)	Pressure Loss (PSI/100' of Pipe)	Velocity (Ft./Sec.)	Meter Size (Inches)	
1000	208	4"	1.5	5.6	4"	
1250	240	4"	1.9	6.4	4"	
1500	267	4"	2.3	7.0	4"	
1750	294	4"	2.8	7.8	4"	
2000	321	6"	0.4	3.7	6"	

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Table O Water Supply Fixture Units (W.S.F.U.) for a Supply System with Flushometer

Water Supply Fixture Units (W.S.F.U.) for a Supply System with Flushometer

W.S.F.U.	Demand (GPM)	Pipe Size (Inches)	Pressure Loss (PSI/100' of Pipe)	Velocity (Ft./Sec.)	Meter Size (Inches)
10	27	1 1/4"	8.3	6.8	3/4"
12	28.6	1 1/4"	9.2	7.2	3/4"
14	30.2	1 1/4"	10.0	7.9	3/4"
16	31.8	1 1/4"	11.0	8.0	3/4"
20	35	1 1/2"	6.0	6.4	3/4"
25	38	1 1/2"	7.0	6.9	1"
30	41	1 1/2"	8.0	7.4	1"
35	43.8	1 1/2"	8.8	8.0	1"
40	46.5	2"	2.5	4.7	1"
45	49	2"	2.7	5.1	1"
50	51.5	2"	2.9	5.4	1 1/2"
60	55	2"	3.4	5.8	1 1/2"
70	58.5	2"	3.7	6.0	1 1/2"
80	62	2"	4.0	6.2	1 1/2"
90	64.8	2"	4.6	6.5	1 1/2"
100	67.5	2"	5.0	6.8	1 1/2"
120	72.5	2"	5.6	7.2	2"
140	77.5	2"	6.3	8.0	2"
160	82.5	2 1/2"	2.7	5.7	2"
180	87	2 1/2"	3.0	6.1	2"
200	91.5	2 1/2"	3.4	6.4	2"
225	97	2 1/2"	3.7	6.8	2"
250	101	2 1/2"	4.0	7.1	3"
275	106	2 1/2"	4.2	7.3	3"
300	110	2 1/2"	4.6	7.6	3"
350	119	3"	2.1	5.5	3"
400	126	3"	2.3	5.9	3"
450	138	3"	2.7	6.3	3"
500	145	3"	3.0	6.8	3"
600	160	3"	3.6	7.4	4"
750	178	4"	1.1	4.7	4"