Commercial Installation Guide

For water hammer control in commercial plumbing applications, such as water closets, urinals and lavs in public restrooms, use the following sizing and placement guidelines based on fixture units.

DETERMINING ARRESTER SIZE BY FIXTURE UNITS

The National Plumbing Code offers this definition of fixture unit: "A fixture-unit is a quantity in terms of which the load producing effects on the plumbing system of different kinds of plumbing fixtures are expressed on some arbitrarily chosen scale." The fixture unit values shown in Table 1 below represent the standard ratings used by engineers to size water distribution systems as well as water hammer arresters. "Public" fixtures, as referred to in Table 1 below, are fixtures found in public rest rooms, office buildings and other places where each fixture is open and accessible for use at all times.

MULTIPLE FIXTURE BRANCH LINES

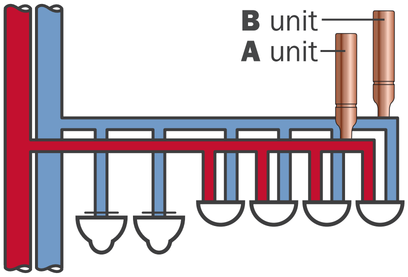
On many types of applications, a single arrester must serve multiple fixtures. In these cases, the total fixture units should be determined for all fixtures served by the branch line where the arrester is to be placed. Once the fixture units for the branch line have been totaled, choose the appropriate arrester by matching fixture units in the table (below) to the arrester size with the corresponding fixture unit capacity. If the total number of fixture units has a fraction, it should be rounded to the next largest whole number. In addition, if the flow pressure at the fixture exceeds 65 psig, the next largest size water hammer arrester should be used.

TABLE 1

FIXTURE	TYPE OF SUPPLY CONTROL	FIXTURE UNITS					
		PUBLIC			PRIVATE		
		TOTAL	C.W.	H.W.	TOTAL	C.W.	H.W.
Water Closet 1.66 PF	Flush Valve	8	8	-	5	5	-
Water Closet 1.66 PF	Flush Tank	5	5	-	2.5	2.5	-
Pedestal Urinal 1.06 PF	Flush Valve	4	4	-	-	-	-
Stall or Wall Urinal	Flush Valve	4	4	-	-	-	-
Stall or Wall Urinal	Flush Tank	2	2	-	-	-	-
Lavatory	Faucet	2	1-1/2	1-1/2	1	1	1
Bathtub	Faucet	4	2	3	2	1-1/2	1-1/2
Shower Head	Mixing Valve	4	2	3	2	1	2
Bathroom Group	Flush Valve Closet	-	-	-	8	8	3
Bathroom Group	Flush Tank Closet	-	-	-	6	6	3
Separate Shower	Mixing Valve	-	-	-	2	1	2
Service Sink	Faucet	3	3	3	-	-	-
Laundry Tubs (1-3)	Faucet	-	-	-	3	3	3
Combination Fixture	Faucet	-	-	-	3	3	3
Clothes Washer	Solenoid Valves	-	-	-	4	3	3
Dishwasher	Solenoid Valve	-	-	-	1.5	-	1.5
Ice Maker	Solenoid Valve	-	-	-	1	1	-

TABLE 2

ARRESTER SIZE	AA	A	B	C	D	E	F
FIXTURE UNITS	1-4	5-11	12-32	33-60	61-113	114-154	155-330



ARRESTER PLACEMENT ON MULTI-FIXTURE BRANCH LINES

Once the correct size arrester has been determined, the final concern is placement of the arrester within the system. Arrester placement depends on the length of the branch line on which the arrester is to be installed, which can be divided into two cases which are described below:

BRANCH LINES OF 20 FEET OR LESS (See Figure 1)

Place arrester at the end of the branch line within 6 feet of the last fixture served, as illustrated on page 15.

BRANCH LINES OVER 20 FEET (See Figure 2)

Calculate fixture units for each 20-foot section separately and place an arrester at the end of each 20-foot section (within 6 feet of the last fixture served in that section) as illustrated in Figure 2 on page 15.

FIGURE 1

If 20ft or less, place one arrester 6ft or less from the end of the run.

FIGURE 2

If more than 20ft, place arrester at the end of each 20-foot section, within 6ft of the end of that section.

Industrial Installation Guide

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The formula below was developed by Sioux Chief as an alternative method of sizing the necessary arrester capacity for large commercial and industrial applications. In these situations, the formula shown below can be used to select the correct size arrester for any given system.

$$C = \frac{1.5 \times L \times V^2}{D^2 \times (P_f + 14.7) \times Y}$$

L = Effective pipe length (in feet)
V = Change in Velocity (in gallons per minute)
D = I.D. of pipe (in inches)
P_f = Flow pressure (PSIG)
Y = A function of P_{ma}/P_{fa} (see graph on following page)
P_m = Maximum allowable pressure (PSIG)
C = Required arrester capacity (in cubic inches)

EXAMPLE

Description of System

L Length of pipe = 200 feet. This is the effective pipe length of the branch line serving the hammering valve. This is where the energy is. As the same flow goes through larger pipes, such as the main trunk line, the energy calculates to be very low and inconsequential.

V Change in velocity = 120 gpm. We can usually assume that our initial flow rate (120 gpm) is equal to the change in velocity, because when we shut off a valve completely, the resultant velocity is always 0. Thus, 120 - 0 = 120. However, if the valve does not completely shut off, and the velocity changes from 120 gpm to 40 gpm, V would then equal 120 - 40 = 80 gpm. This is the most critical factor in the formula, and usually the most difficult to get on an existing installation.

D Pipe size = 3". Try to use the actual I.D. of the pipe if possible. The nominal size of the pipe will get you close to the right answer, but the actual I.D. size will be more accurate.

P_f Flow pressure = 60 psig. This variable is the gauge pressure at the valve when the valve is on. In the formula, we add 14.7 psi (atmospheric pressure) to the gauge pressure to convert it to absolute or **P_{fa}**.

P_m Maximum allowable pressure = 150 psi. This variable represents the pressure to which the sized arrester will limit the shock. It can vary depending on input from the plumber or yourself, but 150 psig is generally used because most plumbing equipment is rated at 150 psig. Also we have observed little or no water hammer noise at this level. In the formula, we add 14.7 psi (atmospheric pressure) to the gauge pressure to convert it to absolute or **P_{ma}**.

FORMULA CALCULATIONS

First we should calculate for the Y Factor. This variable answers the question "What is the maximum allowable pressure in relationship to the flow pressure? Is it twice as much?" To determine this you must divide the maximum allowable pressure (remember to add 14.7 to convert **P_m** to **P_{ma}**) by the flow pressure (remember to add 14.7 to convert **P_f** to **P_{fa}**).

$P_{ma} / P_{fa} = (150 + 14.7) / (60 + 14.7) = 2.2$
$P_{ma} / P_{fa} = 2.2$

Next, look at the graph (on following page) and find the intersection of **2.2** and the **Y** curve. Follow that point straight down to the X axis to read **35**. In this example, **Y = 35**.

Now that you have all the variables, do the original calculation:

$$C = \frac{1.5 \times 200 \times 120^2}{3^2 \times (60 + 14.7) \times 35}$$

$$C = 184 \text{ in}^3$$

ARRESTER SIZING

Choose an arrester that is equal to or larger than the necessary capacity in your calculation. In this example, a 200 cubic inch industrial arrester is the correct choice.

ARRESTER PLACEMENT

Place arrester on supply side of culprit valve within the last 5% of supply line to the valve. In this example, place arrester within 10 feet of the valve.