City of South Salt Lake
Fire Marshal Regulations
for

Water Based Fire Protection and Water Supply Systems

Rev. Oct. 2012

Fire Flow

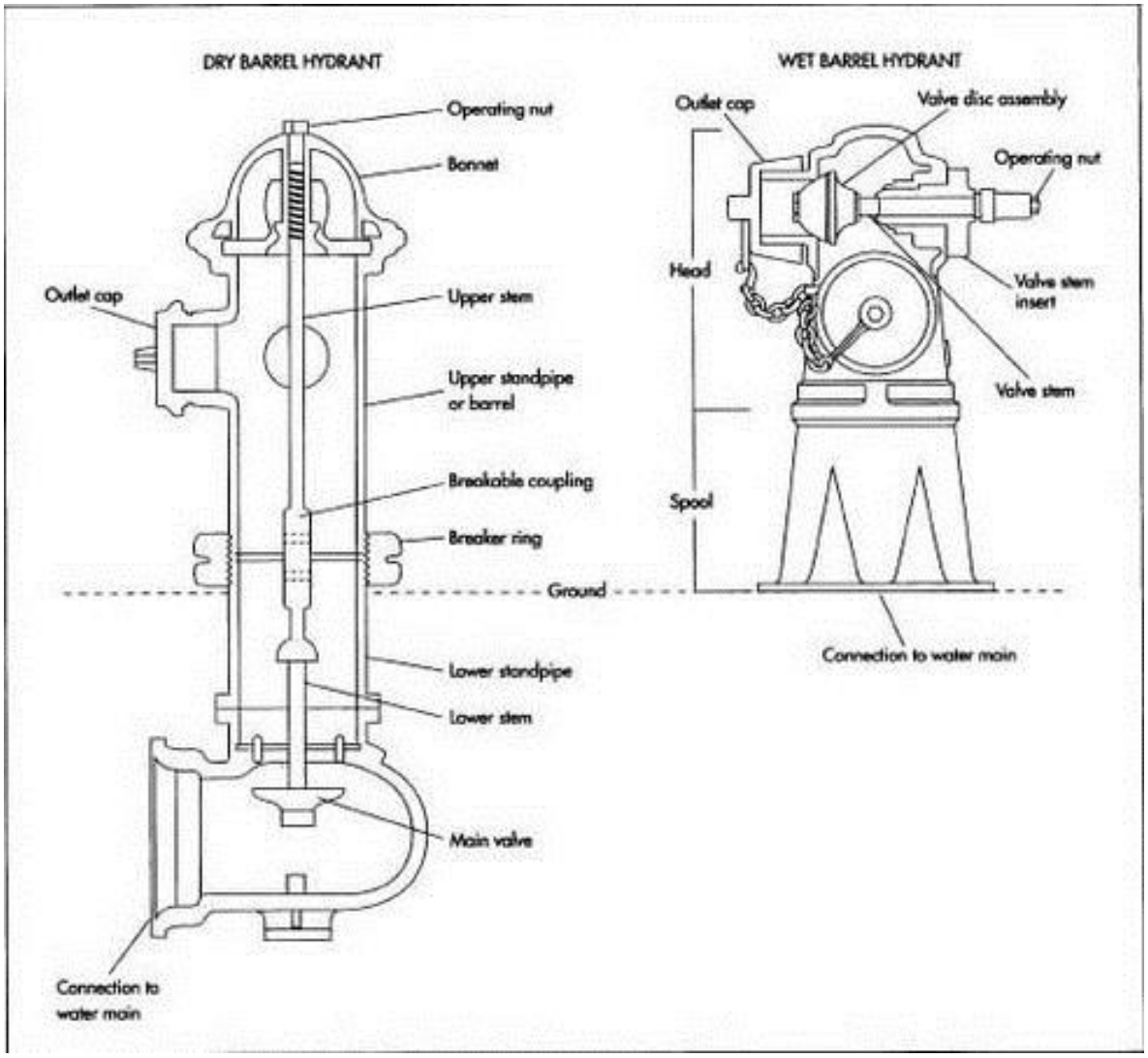
508.1 Required water supply.

- An approved water supply capable of supplying the required fire flow for fire protection shall be provided to premises upon which facilities, buildings or portions of buildings are hereafter constructed or moved into or within the jurisdiction.

Dry Barrel Hydrant

Wet Barrel Hydrant

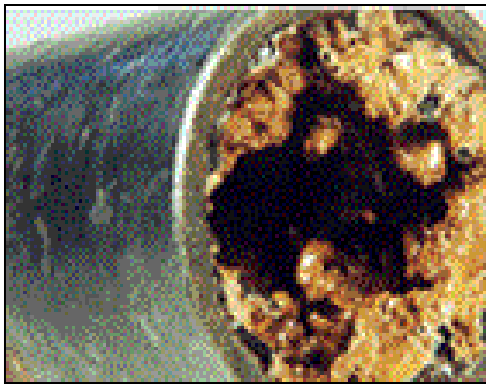
Fire Hydrant Design



Water is necessary!

Proper amounts of water are necessary when any portion of a facility or building to be protected from a water supply on a public street, as measured by an approved route around the exterior of the facility or building.

Note: Fire hydrant tests are important to track historical flow pressure data. Increased friction from sedimentation and/or encrustation can significantly reduce the available pressure and flow.



On Site or “Yard Hydrants”

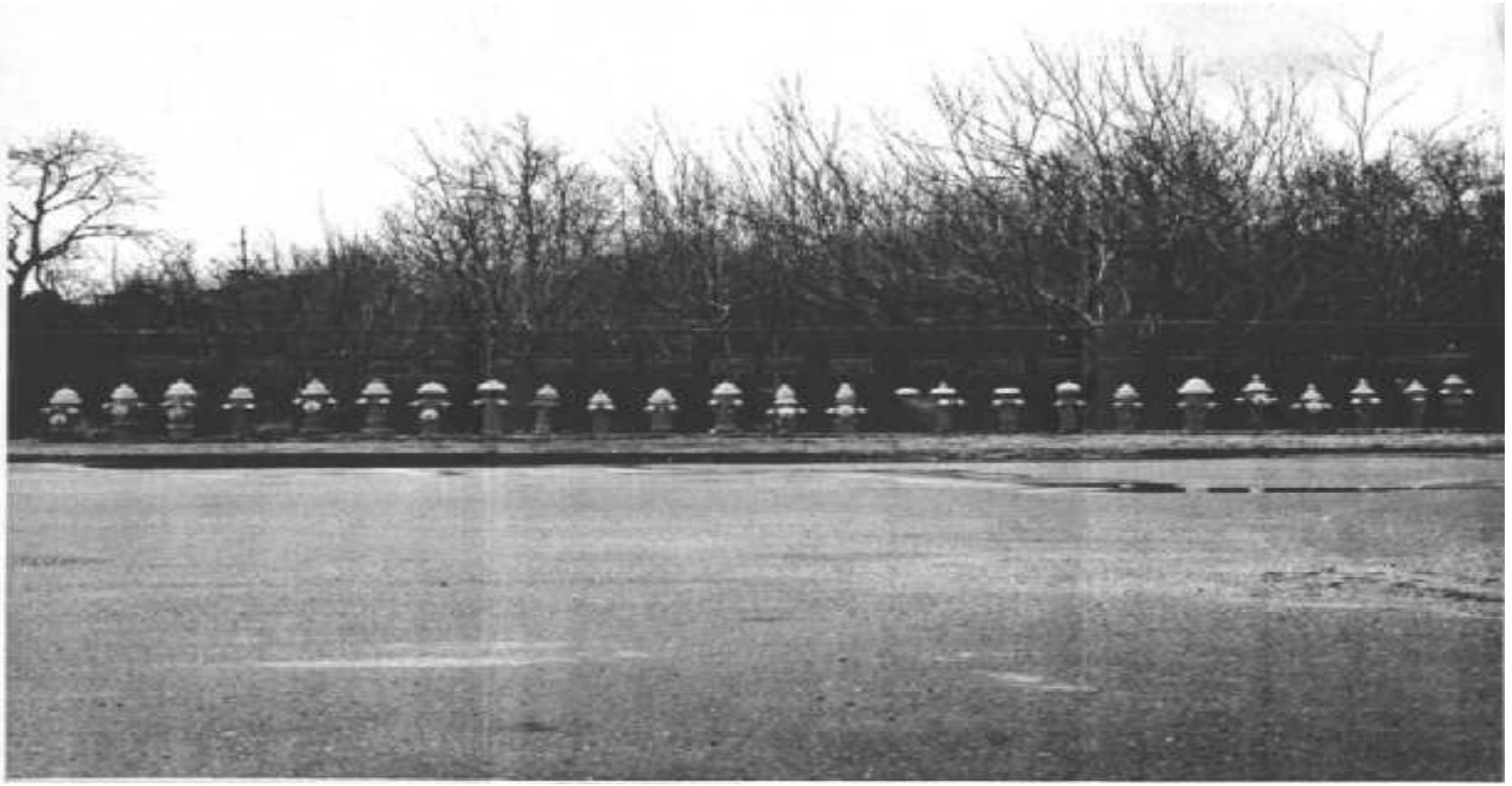
On site fire hydrants (those hydrants not adjacent to the street, but instead they are located out into the property) and mains capable of supplying the required fire flow shall be provided when required by the chief.

This hydrant has the valve stem in the sidewalk area.

The code has the answer

The Fire Code does not establish a specific requirement for flow volume, pressure or duration unless Appendix B and C have been adopted.

Pick a Hydrant… any hydrant



The fire chief can say how many hydrants are required, and where.

Some Communities Have There Own Pre-established Fire Flow Requirements

It is important to remember that Appendix B and C are only applicable if adopted by the local jurisdiction. Many communities have pre-established fire flow and fire hydrant standards. They circulate (loop) their water lines so that a high volume of water exists. This type of a system may be referred to as a “Grid System” Grid systems utilize primary feeders, secondary feeders and distributors to supply the community water system.

FROM ISO's Web Page

- **Water Supply**
- Forty percent of the grading is based on the community's water supply. This part of the survey focuses on whether the community has sufficient water supply for fire suppression beyond daily maximum consumption. ISO surveys all components of the water supply system, including pumps, storage, and filtration. We observe fire-flow tests at representative locations in the community to determine the rate of flow the water mains provide. Last, we count the distribution of fire hydrants no more than 1,000 feet from the representative locations.

Fire Flow and Hydrant Test Calculations

What is “Fire Flow”

- Fire flow is the term used to describe the necessary water required by code. It can also be referred to as: “Required Water Supply”
- **IFC 508.1** An approved water supply capable of supplying the required fire flow for fire protection shall be provided to premises upon which facilities, buildings or portions of buildings are hereafter constructed or moved into or within the jurisdiction.
- NFPA defines Fire Flow as: “The flow rate of water supply, measured at **20 psi** residual pressure, that is available for fire fighting.”

When Should Fire Flow Be Required?

IFC 1412.1 When required.

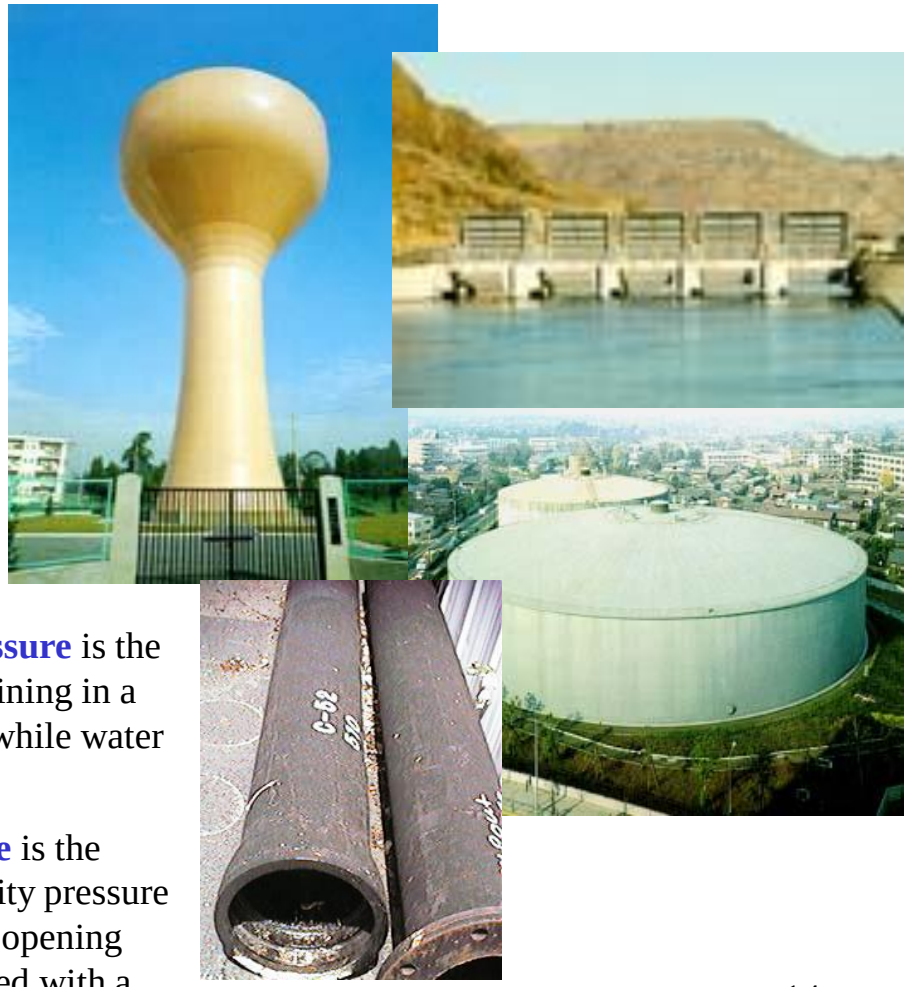
- An approved water supply for fire protection, either temporary or permanent, shall be made available as soon as combustible material arrives on the site.
- The reason for this is that buildings and building materials have been known to burn during the construction process.
- It is also necessary to know available flow pressures so fire sprinkler systems can be designed properly.

Why is this so important?

- Water is necessary for a fire to be extinguished.
- Contractors and owners may want to delay installation of fire hydrants until later in the project. Yet, the moment there is a fire during the construction phase they will want to know why the fire could not be extinguished, and who is at fault.

What types of water supplies are available?

- Reservoirs
- Pressure tanks
- Elevated tanks
- Water mains
- Other fixed systems that are capable of providing the required fire flow.



Terms used: **Static pressure**; water at rest with potential energy expressed in PSI. (Head Pressure)

Normal Operating Pressure; water pressure normally found on a water system.

Friction Loss; pressure lost while forcing water through pipe and fittings.

Residual pressure is the pressure remaining in a water supply while water is flowing.

Flow pressure is the forward velocity pressure at a discharge opening that is measured with a pitot tube.

How is Fire Flow Calculated?

- **IFC 508.3** Fire flow requirements for buildings or portions of buildings and facilities shall be determined by an approved method.

What is the Process?

The following formula is used to determine the amount of water flowing from a fire hydrant.

$$(29.83) x C_d x d^2 x \sqrt{P}$$

- 29.83 is a constant derived from the physical laws relating water velocity, pressure, and conversion factors that conveniently leave the answer in gallons of water per minute.
- C = the coefficient of discharge
- d = the actual diameter of the hydrant orifice.
- P= the pressure in psi as read at the orifice.

Coefficient of Discharge

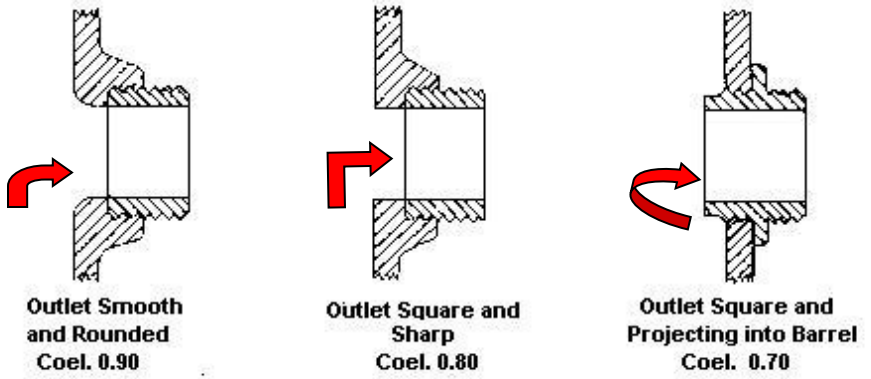


Figure 3. Coefficients of Discharge for Hydrants

- Various hydrant manufacturers have different internal hydrant orifice designs.
- Friction is created as water is required to go around bends or sharp corners.

Take a closer look

- As you can see, the first example has a very smooth, rounded interior orifice transition. Therefore this design has a coefficient of 0.90, or only a 10% loss due to friction loss.
- Other designs have 0.80 or 0.70 for their coefficient numbers.

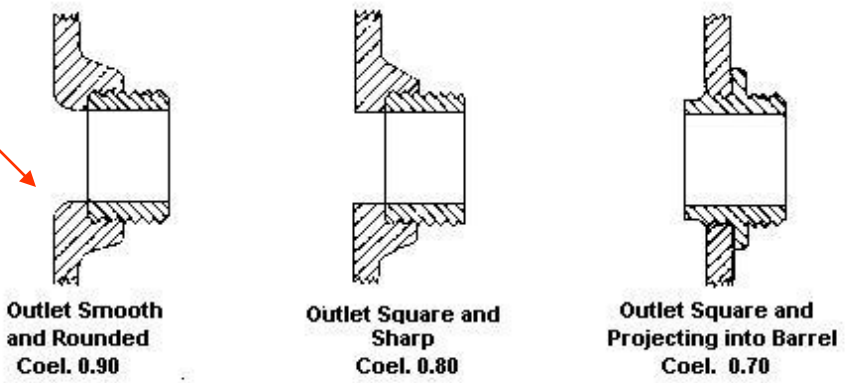


Figure 3. Coefficients of Discharge for Hydrants

Measuring Flow

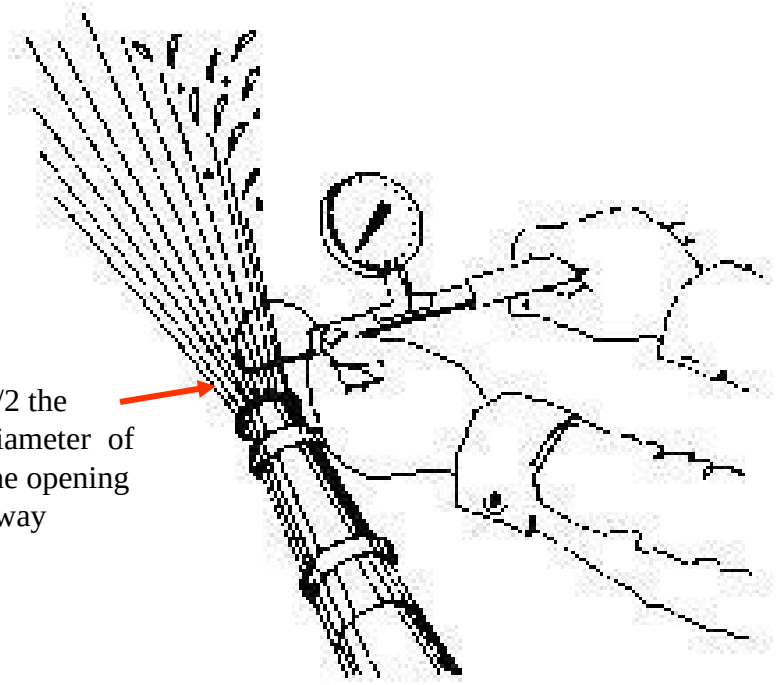


Figure 2. Measuring Flow Rates with a Pitot Tube

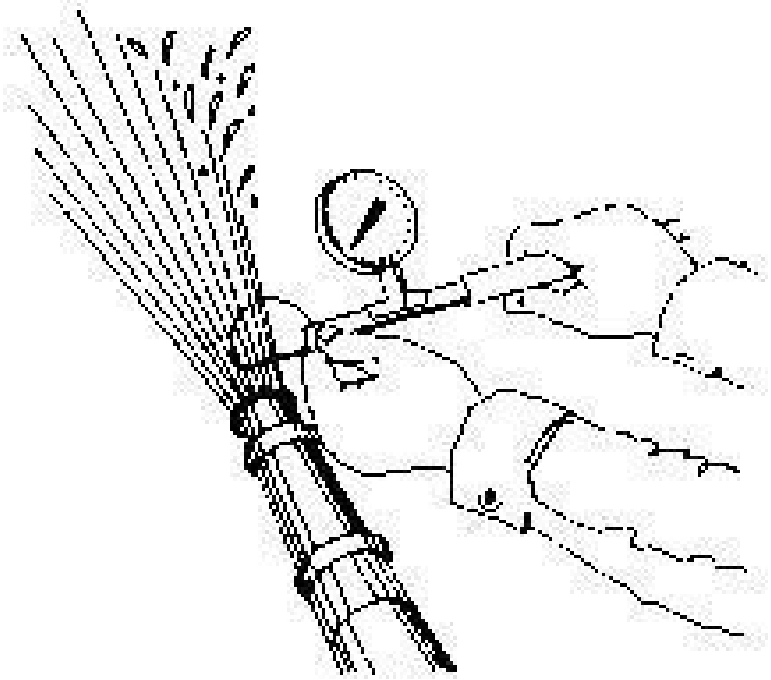
- Use of a Pitot Tube is required.
- **Make sure** you hold the pitot tube and gauge in relation to the orifice outlet.
- The edge of the blade should be placed into the stream one-half the diameter of the opening.
- For a 2 1/2 inch orifice, the blade should be 1 1/4 inches out.

For the purposes of this demonstration a smooth bore nozzle is used.

The procedure is the same for an open hydrant orifice.

Pitot Tube

- A device, essentially a tube set parallel to the direction of fluid-stream movement and attached to a manometer, used to measure the total flow pressure of the fluid stream.
- After HenriPitot (1695–1771), French physicist



Lets Give It a Try

- While testing a single fire hydrant, the static pressure is 82, the flow pressure is 62. One single 2 ½ inch port was used with a measured inside diameter of 2.55 inches. The coefficient is 0.9 What is the total gallons per minute available at normal operating pressure?

Answer

- 29.83 x 0.9 = 26.847
- 2.55 x 2.55 = 6.5025
- 26.847 x 6.5025 = 174.5
- 174.5 x 7.8740 = 1375 gpm

This process will determine the flow of water in gallons per minute from a single fire hydrant, but what if we want to know the total amount of water available in the system?

When determining the pressure and water needed, use the total water available in the system, not just a single fire hydrant.

- Determining the number of hydrants to be opened depends on an estimate of the flow available in the area.
- A very strong probable flow requires several hydrants to be opened for a more accurate test.
- Enough hydrants should be opened to drop the static pressure by at least 10 percent.
- If more accurate results are required, the pressure drop should be as close as possible to 25 percent.

Flow Test Arrangement

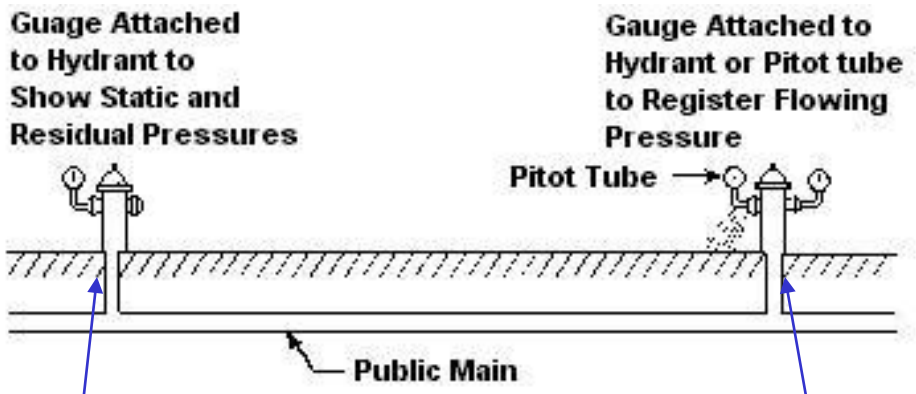


Figure 1. Flow Test Arrangement

This is the test hydrant.

This is the flow hydrant.

- Select the test hydrant first. This should be a hydrant that is not on a dead end water main, and is nearest the building in question.
- Then select the next closest hydrant. This is where a pitot reading will be taken.

What do you record?

- A person at the “Test Hydrant” records the Static Pressure, prior to any water flow down stream. This is done by placing a pressure gauge on one of the hydrant ports and then opening the hydrant. No water will flow, only a static pressure will be obtained at this point.
- When told to do so, a second person opens the next closest hydrant.
- When the second hydrant is open, the test hydrant pressure should drop by 10 percent. Record the residual pressure.
- The second hydrant pressure is measured with the pitot tube. This number reflects flow pressure. This is the number used to determine flow in gpm.
- Remember the formula?

$$(29.83) x C_d x d^2 x \sqrt{P}$$

0.9

I.D. squared

P is the flow pressure from the pitot reading.

An example

- Test Hydrant, Static = 80 psi. Residual = 50 psi.
- Flowing hydrant, Pitot pressure is 45 psi.

What do we do with all the numbers?

- In this example the Test Hydrant had a static pressure of 80 and a residual of 50 psi.
- The flowing hydrant registered a flow pressure of 45 psi on the pitot tube.
- Lets start by determining the flow in gallons of water per minute (gpm) from the flowing hydrant.
- By using the formula and the same hydrant design as before what is the flow in gpm?

Answer . . .

- 29.83 x 0.9 = 26.847
- 2.55 x 2.55 = 6.5025
- 26.847 x 6.5025 = 174.5
- 174.5 x 6.7082039 = **1171 gpm**

What's next in the process of determining total available fire flow?

- The test hydrant had a static of 80. We desire to calculate the maximum flow using mathematics down to a pressure of 20 psi. This is the minimum pressure allowed by most water departments. Lower pressures would begin to cause negative pressures, allowing cross contamination to occur.

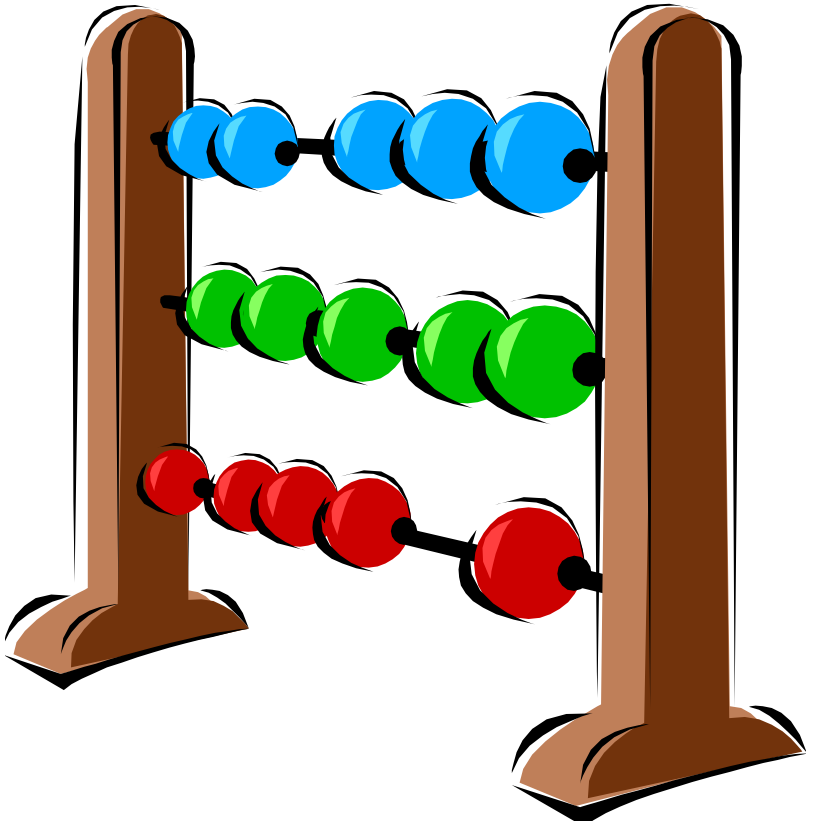
Continued Flow Calculation Process

- Take the Test Hydrant static reading of 80 and subtract 20. This will give you 60 psi. Using a chart find the value for 60 to the 0.54 power. In this case 60 = 9.12.
- Subtract the difference between the static and residual readings, 80 static, 50 residual.
- 80 - 50 = 30 psi. Find the value for 30 to the 0.54 power. In this case 30 = 6.28.
- Then divide 9.12 into 6.28. The answer is 1.4522292.
- Multiply this number into the gpm of 1171.
- 1.4522292 x 1171 = 1701 gpm at 20 psi.

PSI	0.54	PSI	0.54	PSI	0.54	PSI	0.54	PSI	0.54
1	1	41	7.43	81	10.73	121	13.33	161	15.55
2	1.45	42	7.53	82	10.8	122	13.39	162	15.6
3	1.81	43	7.62	83	10.87	123	13.44	163	15.65
4	2.11	44	7.72	84	10.94	124	13.5	164	15.7
5	2.39	45	7.81	85	11.01	125	13.56	165	15.76
6	2.63	46	7.91	86	11.08	126	13.62	166	15.81
7	2.86	47	8	87	11.15	127	13.68	167	15.86
8	3.07	48	8.09	88	11.22	128	13.74	168	15.91
9	3.28	49	8.18	89	11.29	129	13.8	169	15.96
10	3.47	50	8.27	90	11.36	130	13.85	170	16.01
11	3.65	51	8.36	91	11.43	131	13.91	171	16.06
12	3.83	52	8.44	92	11.49	132	13.97	172	16.11
13	4	53	8.53	93	11.56	133	14.02	173	16.16
14	4.16	54	8.62	94	11.63	134	14.08	174	16.21
15	4.32	55	8.71	95	11.69	135	14.14	175	16.26
16	4.47	56	8.79	96	11.76	136	14.19		
17	4.62	57	8.88	97	11.83	137	14.25		
18	4.76	58	8.96	98	11.89	138	14.31		
19	4.9	59	9.04	99	11.96	139	14.36		
20	5.04	60	9.12	100	12.02	140	14.42		
21	5.18	61	9.21	101	12.09	141	14.47		
22	5.31	62	9.29	102	12.15	142	14.53		
23	5.44	63	9.37	103	12.22	143	14.58		
24	5.56	64	9.45	104	12.28	144	14.64		
25	5.69	65	9.53	105	12.34	145	14.69		
26	5.81	66	9.61	106	12.41	146	14.75		
27	5.93	67	9.69	107	12.47	147	14.8		
28	6.05	68	9.76	108	12.53	148	14.86		
29	6.16	69	9.84	109	12.6	149	14.91		
30	6.28	70	9.92	110	12.66	150	14.97		
31	6.39	71	9.99	111	12.72	151	15.02		
32	6.5	72	10.07	112	12.78	152	15.07		
33	6.61	73	10.14	113	12.84	153	15.13		
34	6.71	74	10.22	114	12.9	154	15.18		
35	6.82	75	10.29	115	12.96	155	15.23		
36	6.93	76	10.37	116	13.03	156	15.29		
37	7.03	77	10.44	117	13.09	157	15.34		
38	7.13	78	10.51	118	13.15	158	15.39		
39	7.23	79	10.59	119	13.21	159	15.44		
40	7.33	80	10.66	120	13.27	160	15.5		

Total System Flow at 20 PSI

- Normal flow in gpm for only one hydrant was 1171 gpm.
- When we calculated the pressures and found the maximum flow available at 20 psi, we gained 530 gpm for a total of 1701 gpm.



This process is referred to as a variation of the Hazen-Williams formula. It is used for determining available water. It is written as follows:

$$Q_r = Q_f \, h_f \, \frac{xh}{0.54r}^{0.54}$$

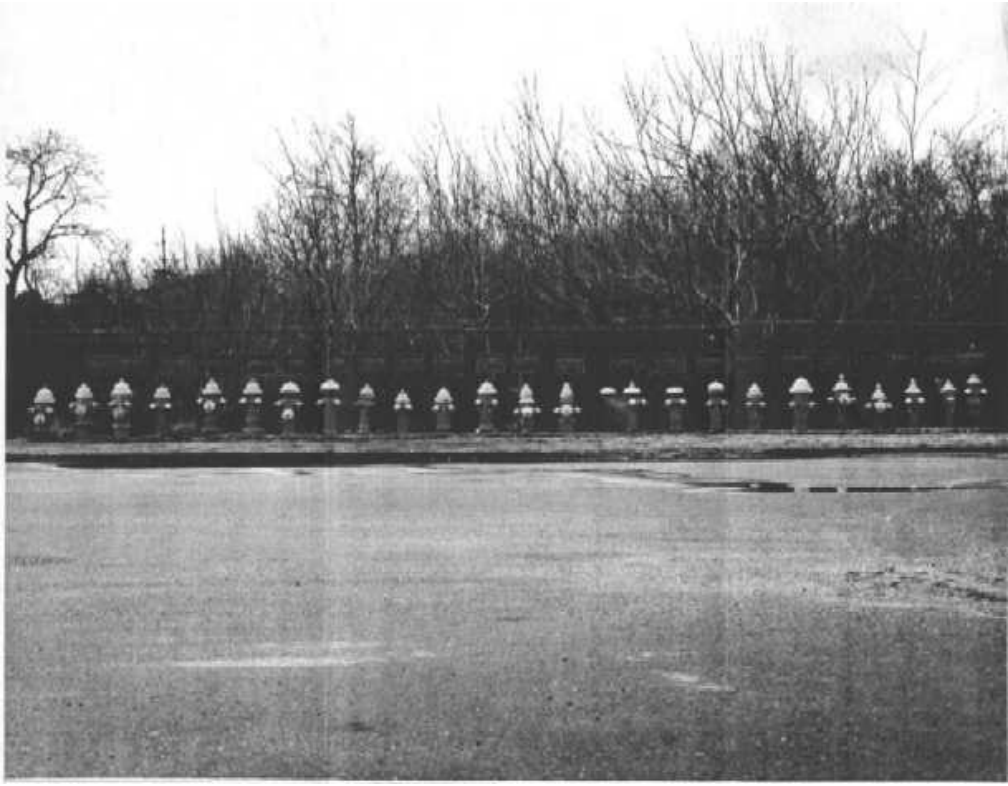
Where are Hydrants Required

- **IFC 508.5.1** Where a portion of the facility or building is constructed or moved into or within the jurisdiction and it is more than **400** feet from a hydrant, on a fire apparatus access road, as measured by an approved route around the exterior of the facility or building.

- NFPA 14: Standard for the Installation of Standpipe, Private Hydrants and Hose
- NFPA 1142: Standard on Water Supplies for Suburban and Rural Fire Fighting
- Local Ordinances

Summary

- Fire flow and fire hydrants are required prior to building construction.
- The amount of available fire flow must be determined in order to know what amount of water is available. Water mains may need to increase in size to meet code. Additional fire hydrants may also be required.



Thank you

- Questions ?