FIREFLOWS

This discussion will include information on making and interpreting flow tests on fire hydrants. We won't have an actual field test today, but we have a few slides showing a typical flow test.

WHY MAKE FLOW TESTS?

Now that we have seen the slides, the following discussion may have added meaning. We shall begin by defining fireflow. Fireflow, is the amount of water in gallons per minute (G.P.M.), at a given residual pressure available from the fire hydrants, for the purpose of fighting fires. A flow test, as the slides indicated, can be used to determine the amount of fireflow available in a given area. Flow tests are also used for determining if the distribution system is adequate to serve additional large customers or developments.

HOW TO MAKE FLOW TESTS

Equipment needed.

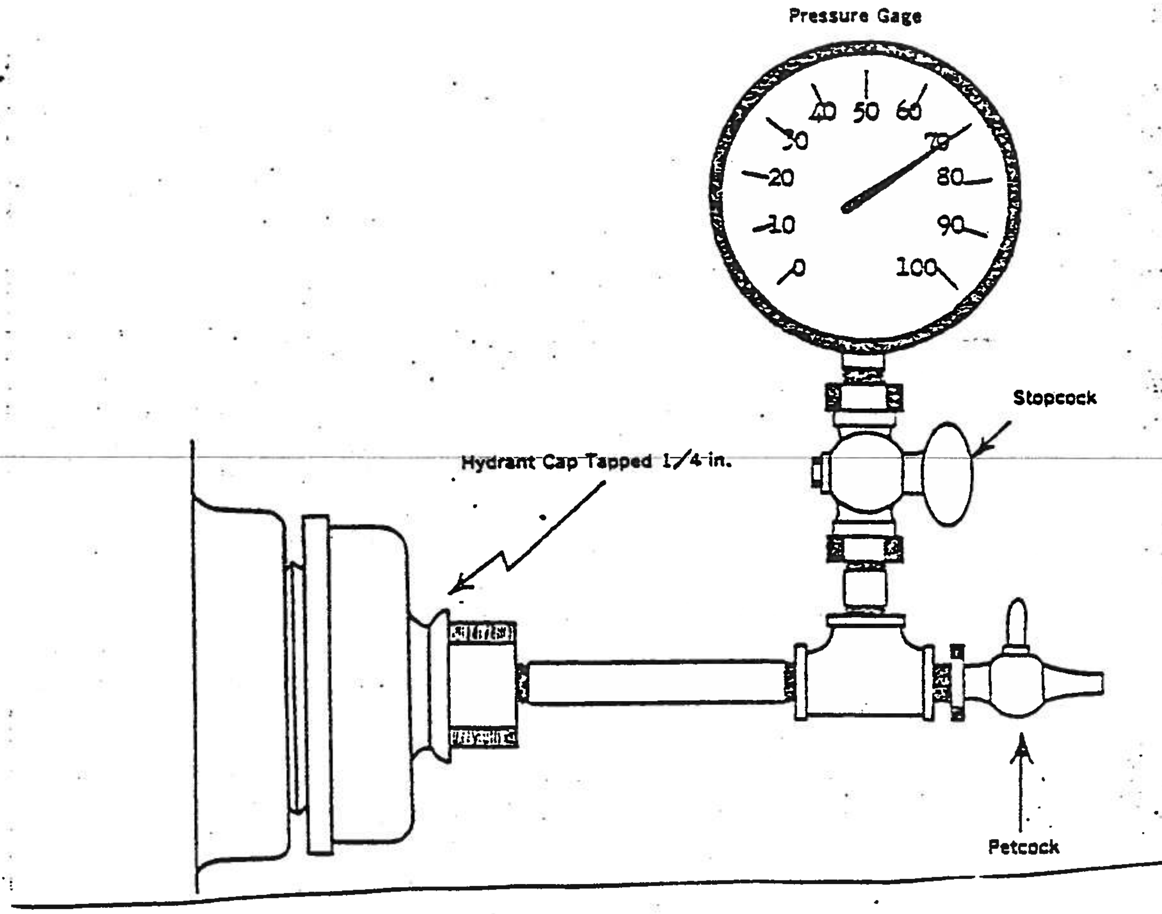
a. 100 to 300 P.S.I. gauge for the residual hydrant.

b. 30 to 100 P.S.I. gauge for each flow hydrant.

c. Pitot blade. (not always used)

d. 2-1/2" hydrant caps, tapped with 1/4" brass pipe, with a tee having a branch for blowing off air, and another branch for connecting a gauge. (One of these assemblies is needed for the residual hydrant, and one is needed for each flow hydrant, if a pitot blade is not used.)

e. Hydrant wrenches.



Preparing for the Test

Before making the flow test, it is wise to do some preliminary investigation. Distribution maps should be studied to determine which hydrants are to be used. The residual hydrant is the one nearest the problem area. Once it is located on the distribution map, the U.S.G.S. map for this area should be checked. The elevation found on the U.S.G.S. map can be translated into psi (pounds per square inch) static pressure at the residual hydrant. The following example illustrates this:

> Say the elevation at the residual hydrant is found to be 1,200 feet. The reservoir or tank serving the area has an overflow elevation of 1,385 feet. The hydraulic head is then 1,385 feet minus 1,200 feet, or 185 feet. To convert this to psi, divide the 185 feet

by 2.31 feet per psi. The result is 80.1 psi. Another method is to multiply the 185 feet by .433 psi per foot The same answer, 80.1 psi results. The basis for either calculation is that one psi is equal to 2.31 feet of water. This concept must be understood if flow tests are to have any meaning.

Once the static pressure at the residual hydrant is determined, a gauge can be selected. Using the above example, a 150 psi gauge would be adequate since 80 psi is the greatest static pressure expected. (Ideally, the actual static pressure should fall at mid-range of the gauge.)

The next step is to study the existing mains to determine how strong the distribution system appears. Based on previous flow testing experience, it may be possible to decide about how much flow in GPM (gallons per minute) can be expected. For flows of 1,000 GPM or less, one flow hydrant would be adequate. Larger flows may indicate the use of multiple flow hydrants or at least using the pumper nozzle instead of a 2½" nozzle.

If an approximate flow can be guessed at, then the proper size gauge may be determined for the flow hydrant. To avoid damaging the gauge, use a larger size if not sure (say 100 psi). More accuracy can be expected, however, if the gauge size is nearer the actual requirements. When using a pitot blade, a smaller gauge (30 psi) is generally used. For very small flows the 2½" nozzle may be too large to get a reading on the gauge. Then it would be necessary to reduce the nozzle size with an adapter.

Before using the gauges selected, it is necessary to know if these gauges are accurate. If they haven't been tested recently, or if the test paper has been lost, it will be necessary to calibrate the gauges by use of a dead-weight tester. (If time permits, show how to use a dead-weight tester.)

Making the Flow Test

After assembling the necessary equipment, proceed to the test site. The hydrants selected on the map are then checked to see if they can actually be used. It should be possible to control the flow during the test so as not to damage property or interfere excessively with traffic flow. Both residual and flow hydrants must operate properly. If there are any problems, new hydrant locations may have to be used.

Once the hydrants have been selected, the test may begin. The residual hydrant is prepared first. One 2½" hydrant cap is removed and replaced with a tapped 2½" hydrant cap and gauge assembly. The petcock is opened on the air blow-off and the petcock before the gauge is closed. The hydrant is then opened slowly, and air is allowed to bleed off. When water appears at the air blow-off, it may be closed. The petcock before the gauge may now be opened. The gauge will then begin to register. A few more turns to open the hydrant may be needed to obtain full static pressure on the gauge. This pressure is then recorded.

The flow hydrant is set up next. One 2½" hydrant cap is removed and replaced with a similar assembly as used at the residual hydrant. (A pitot blade may be used on the flow hydrant instead of the tapped hydrant cap. Only one cap would be removed and the pitot blade with attached 20 or 30 psi gauge held in the middle of the flow. This method is difficult with high velocity flows.) The petcock on the air blow-off is opened and the petcock leading to the gauge closed. The other 2½" hydrant cap is then removed. The inside diameter of the nozzle is measured and the shape of the nozzle in the barrel is observed. At this point make sure no one is standing in front of the open nozzle! The hydrant is opened slowly, and air is bled off the gauge's blow-off as was done at the residual hydrant. The petcocks are set and the hydrant opened slowly until fully opened. The gauge is then observed. The needle may be bouncing rapidly at first. The hydrant should be kept fully opened for two to three minutes until the gauge settles down. Then the gauge should be read. An observer at the residual hydrant should read and record the pressure at that hydrant at the same time. The flow hydrant should now be shut down slowly to avoid water hammer. The residual hydrant should be read again for static pressure and also shut down. Both hydrants should be drained and the gauges and tapped hydrant cap assemblies removed.

How to Interpret Flow Test Results

After a flow test is made and the resulting pressures recorded, the information must be interpreted if it is to have any meaning. The pressure recorded at the flow hydrant is converted to flow by formula or table. The basic formula is: $Q = 29.83\, c\, d^2 \sqrt{p}$

Q = Flow, in GPM

c = Hydrant Coefficient (Usually 0.9)

d = Diameter of Nozzle, in Inches

p = Pressure, in psi, of Flowing Nozzle Read on Gauge on Tapped Hydrant Cap or Pitot Blade

Example:

Given:

Hydrant Nozzle = 2.5 Inches

Hydrant Coefficient = 0.9 - USE .95

Pressure at Flow Hydrant = 25 psi

$$Q = 29.83\ c\ d^2 \sqrt{p}$$

$$Q = 29.83\ (0.9)\ (2.5)^2 \sqrt{25\ psi}$$

$$Q = \underline{839\ GPM}$$

The residual hydrant also is read during the test. Following the above example, let's say the static pressure at the residual hydrant is 80 psi. During the flow test the pressure drops to 45 psi. Then we can say that at 45 psi pressure, 839 GPM fireflow is available.

How to Use Information from a Flow Test

Fireflows are usually required to be found at a 20 psi residual pressure. The above example if converted to a 20 psi residual pressure would yield 1,120 GPM. Various tables, graphs and formulas or a hydraulic slide rule may be used to convert flow test results to desired residual pressures. The actual method of doing this will not be discussed at this time. Analysis of the strength of the distribution system to determine main extensions and reinforcing may also be performed from flow test data by trained personnel.

Effects on Flow Tests on Distribution Systems

A flow test should be made at periods of maximum water usage, usually in the middle of the day. The reason for this is to simulate the worst possible actual condition at which a fire could occur.

While making a flow test, pressures will drop in the immediate vicinity of the test. If, as our example shows, pressures drop from 80 psi to 45 psi, a situation could occur as follows: An apartment building sits near the residual hydrant with its bottom floor at an elevation of 1,200 feet. The top floor of the building is at an elevation of 1,340 feet. During the flow test the 45 psi residual pressure would equate to 104 feet of

QUICK REFERENCE FLOW TABLES

Pitot Tube Pressure (P.S.I.)	Discharge Gallons Per Minute				
	1-1/8"	1-3/4"	2-1/2"	4"	4-1/2"
5	84	203	380	960	1,220
6	92	223	410	1,050	1,340
7	99	241	440	1,140	1,440
8	106	257	480	1,220	1,540
9	112	273	500	1,290	1,640
10	118	288	530	1,360	1,730
12	130	315	580	1,490	1,890
14	140	340	630	1,610	2,040
16	150	364	670	1,720	2,180
18	159	386	710	1,820	2,310
20	167	407	750	1,920	2,430
22	175	427	790	2,020	2,550
24	183	446	820	2,110	2,660
26	191	464	860	2,190	2,770
28	198	481	890	2,280	2,880
30	205	498	920	2,350	2,980
32	212	514	950	2,430	3,080
34	218	530	980	2,510	3,170
36	224	546	1,010	2,580	3,260
38	231	561	1,040	2,650	3,350
40	237	575	1,060	2,720	3,440
42	243	589	1,090	2,780	3,520
44	248	603	1,110	2,850	3,610
46	254	617	1,140	2,920	3,690
48	259	630	1,160	2,980	3,770
50	265	643	1,190	3,040	3,860
52	270	656	1,210	3,100	3,940
54	275	668	1,230	3,160	4,010
56	280	680	1,250	3,220	4,080
58	285	692	1,280	3,280	4,160
60	290	704	1,300	3,330	4,230
62	295	716	1,320	3,380	4,300
64	299	727	1,340	3,440	4,360
66	304	738	1,360	3,490	4,430
68	308	750	1,380	3,540	4,500
70	313	761	1,400	3,600	4,560
72	318	771	1,420	3,650	4,630
74	322	782	1,440	3,700	4,680
76	326	792	1,460	3,750	4,740
78	330	803	1,480	3,790	4,810
80	335	813	1,500	2,840	4,870
82	339	823	1,520	3,890	4,930
84	343	833	1,540	3,940	4,990
86	347	843	1,560	3,980	5,040
88	351	853	1,580	4,030	5,100
90	355	862	1,590	4,080	5,160