FOREST SERVICE TECHNOLOGY & DEVELOPMENT PROGRAM

USDA Forest Service
Technology & Development Center
444 East Bonita Avenue
San Dimas, CA 91773
714/599-1267, FAX 592-2309
FTS 793-8000/DG:W07A

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PUMP FLOW TESTING

by Dan McKenzie, Mechanical Engineer

With a little ingenuity, firefighting personnel can determine the flow rate of a pump using equipment on hand (a short piece of pipe, a tape measure, a level, and a plumb bob) and at almost no cost. Knowing how to go about this can be very handy, since accurate flow meters are often not immediately available for firecrew use. This method of determining pump flow rate is very accurate and needs no calibration. It is based on the principle that when an object is released it falls at a given rate, independent of its horizontal velocity. So when water is released from a pipe that is at a given height from the ground, it always hits the ground in the same time.

As explained in detail below, how far away from the pipe exit that the water hits the ground is directly proportional to the water's horizontal velocity as it exits the pipe. Further, the horizontal velocity is directly proportional to the amount of water coming out of the pipe, and depends on the area of the pipe opening. Knowing this area, the height of the pipe exit above the ground, and the the distance out from the pipe that the water hits the ground; the water flow rate can be accurately calculated using the formula given at the very end of this text.

For want of a better name I call this pump flow test method a "splash test." The steps to take to accomplish a slash test are:

A. Couple a short length (3 to 4 ft) of pipe of known ***inside*** diameter to the hose coming from the pump. (*NOTE*: In some cases, as flow rates approach maximum, hose ripple can occur. To prevent this, use either hard suction hose or a longer pipe.)

B. Mount the pipe level, horizontally, at a convenient height ("h") above the ground. (*NOTE*: Select the height suggested in the table for the pipe size and flow ***range*** you are going to use to avoid having to do a sequence of calculations.)

C. Run the pump and have the water splash on the ground.

D. Measure the distance ("D") along the ground from the end of the pipe to where the water hits the ground (fig. 1). At the time of the measurement, the hose must be running full of water. Let a plumb bob hang from the pipe exit down to the ground—this locates where to start measuring "D."

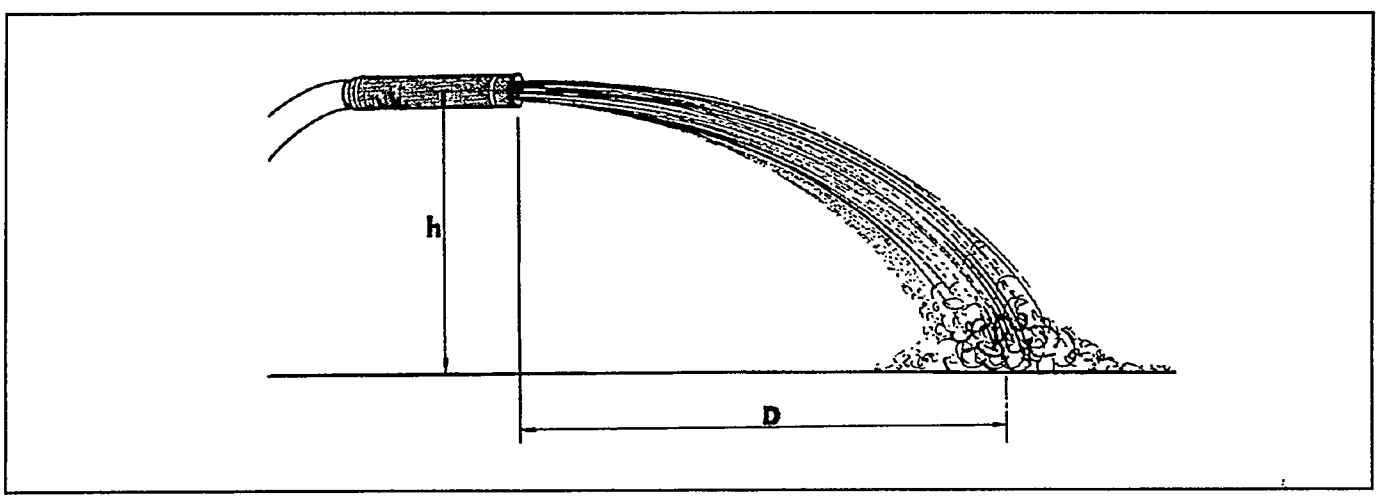

Figure 1. Relation of pipe exit to "h" and "D."

How far out from the end of the pipe that the water hits the ground depends on the horizontal velocity as the water exits the end of the pipe. The higher the exit velocity, the higher the "D;" i.e., "D" is directly proportional to water flow velocity. Knowing "D" and the height of the pipe ("h") above the ground, the velocity of the water out of the the pipe can be determined. From this and the pipe exit area, the flow rate can be calculated.

To obtain the flow rate in gpm for the pipe size being used, when employing the height suggested in the table, multiply "D" by the gpm per inch found in the final column of the table. *NOTE:* Be sure to check the inside diameter of the pipe being used to see if it is as listed in the table; if it is not, ***the flow formula, presented following the table, must be used***—as would be the case ***for any setup (pipe size or height) that is not presented in the table.***

Mounting the pipe on a fork lift is very convenient way of holding the pipe (fig. 2), since now the pipe can easily be adjusted either horizontally or vertically. And, if the test is conducted at a station or work center, a pipe can be mounted permanently on a stand or building, and permanent marks placed on the ground (these can be in gpm). This would permit flow tests to be conducted very quickly and easily. Remember that a splash test only determines the gpm flow from the pump. To check pump performance, the pressure at which the water is flowing must also be known. The engine pressure gauge can be used to obtain this pressure by partially closing the overboard discharge valve to create a resistance for the pump.

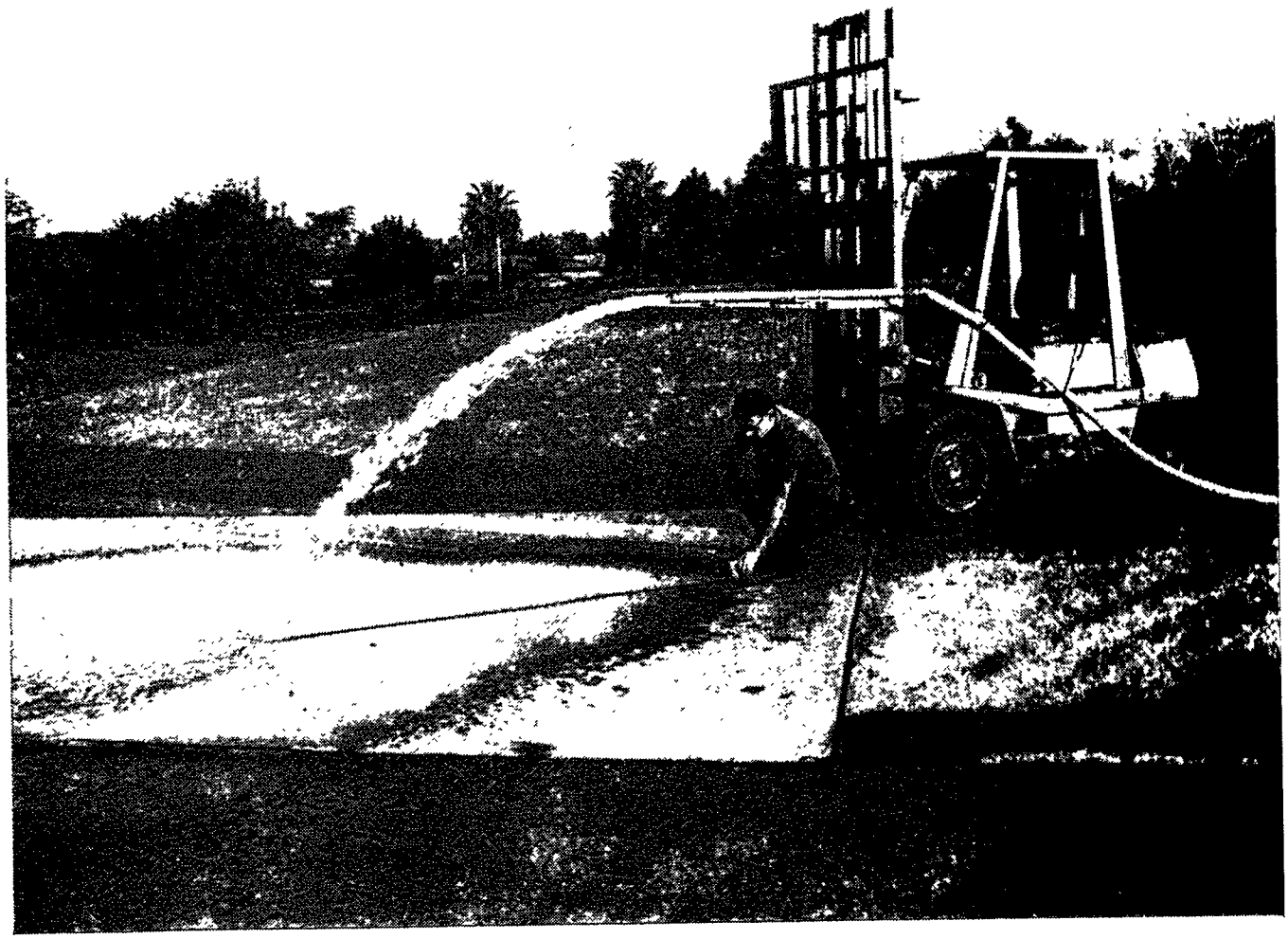

Figure 2. Splash test with 1-1/2-in pipe at suggested height of 54-1/4 in; the calculated flow rate was 84 gpm.

As there is a limited number of pipe sizes and practical heights for the water to fall from each of these pipes, the following table has been developed:

Splash test table

Pipe size (in)	Pipe ID (in)	Pipe opening area (sq in)	Flow Range (gpm)	Suggested height (in)	Unit linear flow @ suggested height (gpm/in)
0-1/2	0.62	0.30	2-10	18-3/4	0.25
0-3/4	0.82	0.53	5-20	29-7/8	0.35
1	1.05	0.86	10-40	38-9/16	0.5
1-1/4	1.38	1.50	20-100	45-13/16	0.8
1-1/2	1.61	2.04	40-150	54-1/4	1.0
2	2.07	3.36	60-250	65-3/8	1.5
2-1/2	2.47	4.79	100-400	74-3/4	2
3	3.07	7.39	150-600	79-1/8	3
4	4.03	12.73	200-900	84-1/2	5
5	5.05	20.01	300-1200	81-1/2	8
6	6.07	28.89	400-1600	108-3/4	10

For pipe ID's or heights not in the table, the flow rate can be calculated using the following formula:

$$\text{Flow (gpm)} = 3.61 \times AD/(h)^{1/2}$$ [$(h)^{1/2}$ = square root of h]

where:

A = Area (in square inches) of the pipe opening = $(3.14) \times (r^2)$
[r = 1/2 of pipe ID (in)]

D = Distance along ground (in inches) from the pipe exit to the midpoint of where the main body of water splashes.

h = Height above ground (in inches) of the midpoint of the pipe exit.

3.61 = Constant that adjusts answer for measurement units used in formula.