TASK FORCE TIPS
FIRE FIGHTING EQUIPMENT

FIRE STREAMS TECHNICAL INSTITUTE
TECHNICAL BULLETIN LTT-107

The Comparison Of Various Types Of Nozzles Operating At Specific Flows And Pressures And Their Effect On The Impact Or "Punch" Of Fire Streams

"A fire stream can be defined as a stream of water, or other extinguishing agent, after it leaves the fire hose and nozzle until it reaches the desired point in the desired configuration. During the time a stream of water passes through space, it is influenced by its velocity, gravity, wind, and friction with the air. The condition of the stream when it leaves the nozzle is influenced by operating pressures, nozzle pressures, nozzle design, nozzle adjustment, and the condition of the nozzle orifice."

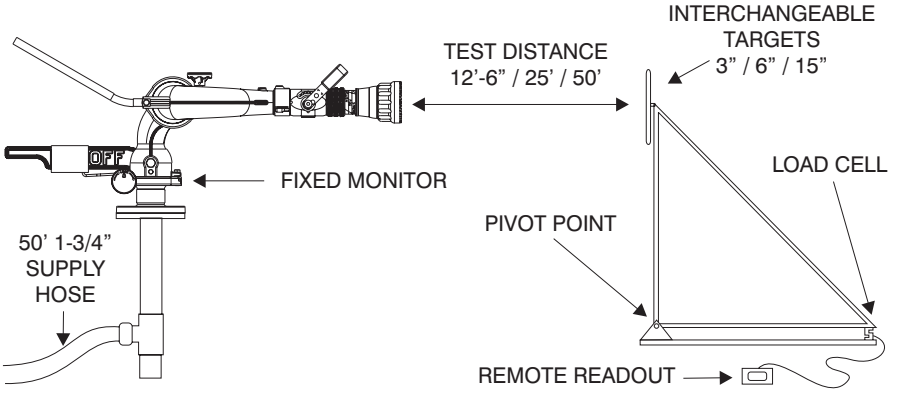
This opening statement from the IFSTA 105 "Fire Streams Manual" sums up the rules that affect fire streams and their characteristics. When testing or evaluating nozzles, the fire service generally measures flow and pressure as its primary yardstick for comparison of nozzles. Additionally, much controversy has recently surfaced concerning the ability of one type of fire stream to out-perform another. Much of the currently available comparative data is subjective in nature with little or no evidence to support any claims made.

One specific characteristic of a fire stream that has not been measured to date is the "hit" or "punch" of a fire stream. This particular characteristic clearly divides the smooth-bore advocates from those in the adjustable pattern (fog) nozzle camp. Proponents of smooth-bore fire streams claim that for greater impact, a smooth-bore nozzle must be used. Others claim that an adjustable pattern nozzle set to the straight stream position, and flowing the same amount of water at the same nozzle pressure will have similar results.

As a result of this controversy, Task Force Tips engineered a test method to accurately measure the impact of a fire stream. The device used consists of a test stand that utilizes interchangeable 15", 6" and 3" diameter circular "targets" that are attached to the vertical member of the test apparatus. The vertical support of the test stand in turn connects to a horizontal leg of the test stand. The horizontal leg and vertical support pivot at the base. A compression load cell is located on the horizontal leg a distance that is equal to the distance from the pivot point to the center of the target. The impact of the stream will push the target and the vertical support. The vertical support will transfer the force to the horizontal leg and load cell. The load cell will indicate the impact of the fire stream in Ibs/force.

A flow of 160 gallons per minute was selected for the comparisons. This flow rate represents a typical attack flow. Each nozzle was operated at or very near this flow rate. This provided a constant measurement to which the different operating pressures and nozzle types could be compared. The smooth-bore nozzle and the adjustable pattern nozzle were both operated at 50 and 100 psi at a similar 160 GPM flow rate. This was done to compare the impact of each type of nozzle at different

TEST SET-UP



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nozzle pressures. Additionally, by comparing the impact with different types of nozzles at the same flow and pressure, the performance capability of one type of nozzle over another can be determined. A 7/8" smooth-bore was used to deliver 160 GPM at 50 psi, and a 3/4" smooth-bore was used to deliver 166 GPM at 100 psi. A TFT Model H-VPGI adjustable pattern nozzle was calibrated to deliver a similar 160 GPM at 50 psi, and a standard TFT Model H-VPGI was used to deliver 166 GPM at 100 psi. To determine the impact of low pressure nozzles, a TFT Model H-VPGI was also calibrated to operate at 160 GPM at a nozzle pressure of 75 psi.

The impact measurements were taken at distances of 12'-6", 25', and 50'. The measurement was from the target face to the point at which the water exited each nozzle. At the 12'-6" distance, the 3" target was used. This was done to address the claim of smooth-bore advocates that "solid" streams are more compact than "hollow" streams from adjustable pattern nozzles, and therefore have more impact. At the 25' distance the 6" target was used, and at 50' the 15" target was utilized.

To secure the nozzle, a 1-1 /2" Stang monitor was utilized. This also assured accurate readings by keeping the nozzle stationary once water was flowing, and eliminated any error caused by hand-holding the nozzle. The Stang monitor was fed with 1-50' section of 1-3/4" hose. The GPM Hale Model FB-100-F460 fire pump. A KGK Model EMF-100 Electromagnetic Flowmeter was utilized to verify the flow rate compared with a pitot reading of the GPM Hale Model FB-100-F460 fire pump. A KGK Model EMF-100 Electromagnetic Flowmeter was utilized to verify the flow rate compared with a pitot reading of the flowmeter data as well as the impact force and nozzle base pressure were recorded for each test on a YEW ER-250 Model 488 30 channel chart recorder. One set of tests at each distance (12'-6", 25', 50') with the 5 different nozzles yielded a total of 15 sets of data. Each test was run for approximately 3 minutes to insure sufficient data was collected to average the results.

The first series of tests used a 3" target at a distance of 12'-6" (Chart "A"). At that distance there was no difference in the impact from either the smooth-bore or the

Chart "A"

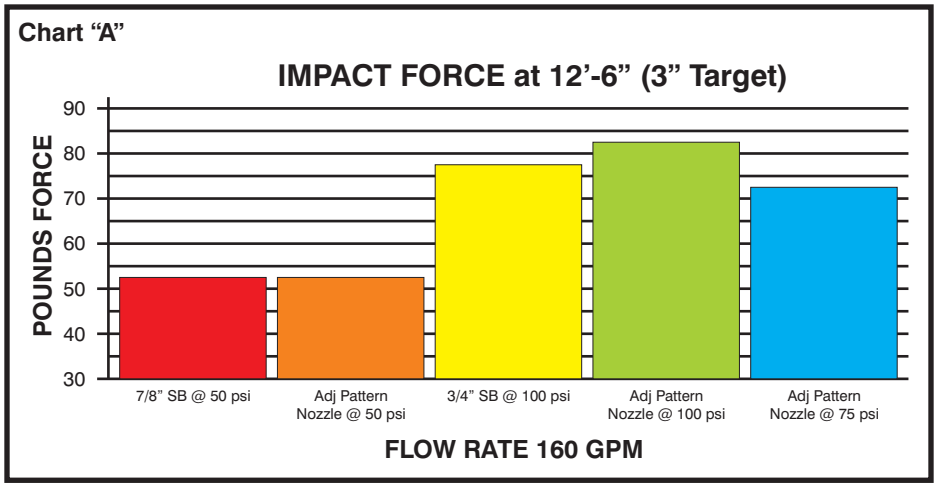


Chart "B"

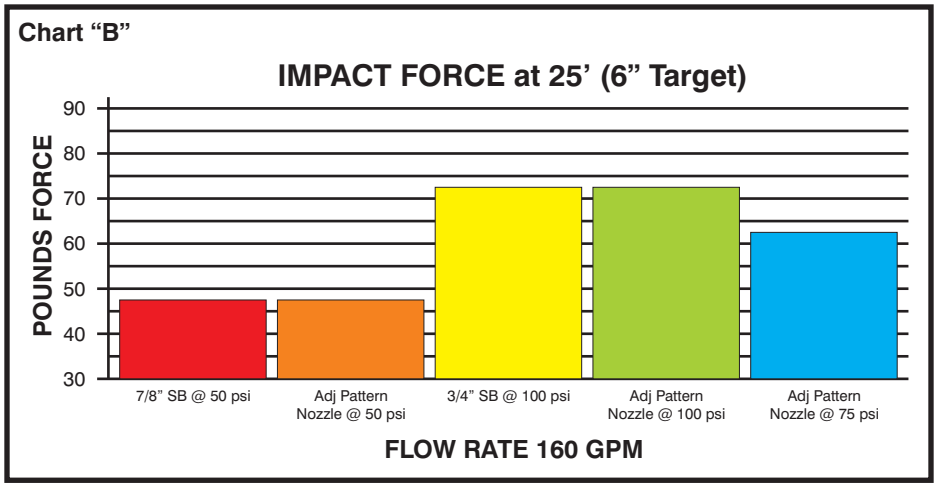
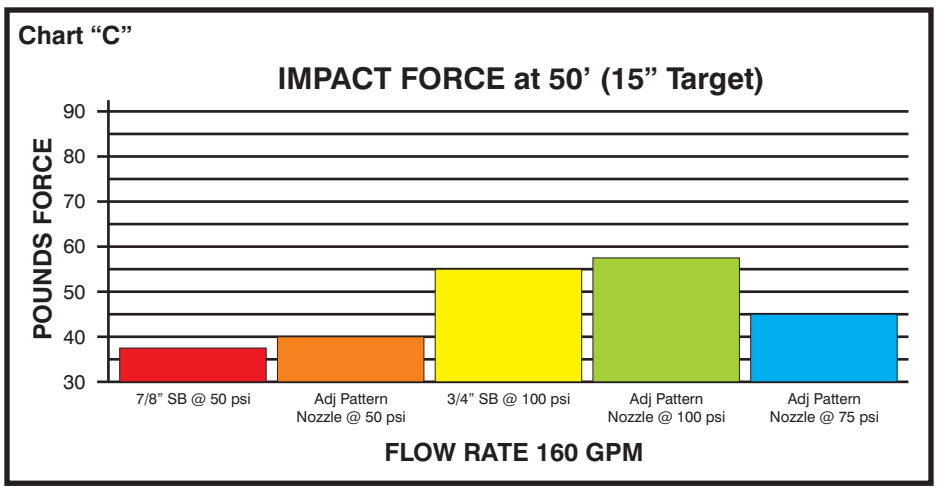


Chart "C"



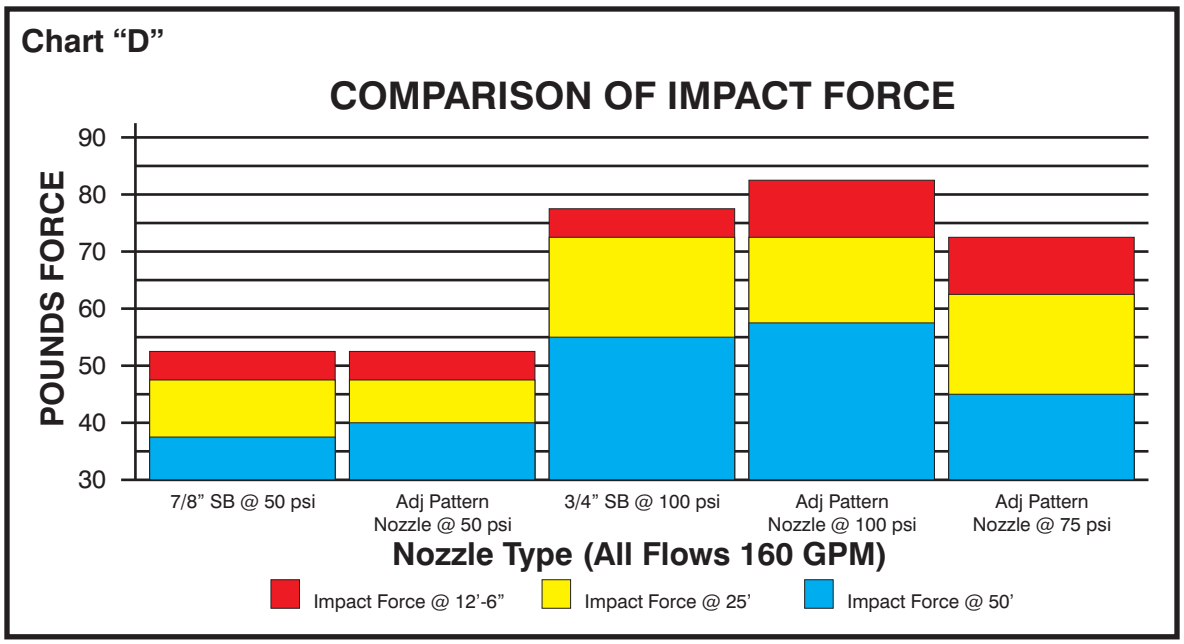
adjustable pattern nozzle at 50 psi nozzle pressure. At 100 psi nozzle pressure at the same distance, the adjustable pattern nozzle developed 10% more impact than its smooth-bore counterpart at a like flow and pressure. The 75 psi nozzle developed impact values as expected between the 50 psi and 100 psi nozzles. It is interesting to note (and logical based on Newton's theory) that at this distance the impact values for each nozzle are very close to the reaction values for that type of nozzle operating at that pressure and flow.

The second series of tests (Chart "B") were conducted in the same manner as the first series of tests except the target was moved further away to 25 feet and the target size was increased to 6". Again, either at 50 psi nozzle pressure or 100 psi nozzle pressure, there was no noticeable difference in impact for either the adjustable pattern nozzle or the smooth-bore. The 75 psi nozzle again performed as expected, with impact forces between the tests for high and low pressure nozzles at this distance.

In the third series of tests (Chart "C") the target was moved to a distance of 50 feet and the target again increased in size to 15 inches to compensate for the additional distance. At the 50 foot range, the adjustable pattern nozzle developed slightly greater (5%) impact force than the smooth-bore nozzles at either 50 psi or 100 psi. At the 50 foot distance the 75 psi adjustable pattern nozzle again developed impact forces between the 50 psi adjustable pattern nozzle and the 100 psi adjustable pattern nozzle.

Referring to the bar graphs of each series of tests, (Chart "D") it is obvious that there is little difference between the "punch" or "hit" of a fire stream based on the type of nozzle that the fire stream exits from. Rather the impact ("punch/"hit") is more a function of the velocity of a fire stream (pressure) and its mass (GPM). If the flow rate and pressure of the two fire streams are similar, the impact force that those fire streams produce will be similar also. The smooth-bore nozzle has NO ADVANTAGE over the adjustable pattern nozzle when it comes to impact capability. Conversely, if the impact forces of the two types of nozzles are similar, then the adjustable pattern nozzle is preferable due to its ability to vary the pattern to suit the need of the firefighting team at any given moment. If the best of both worlds are desired, an automatic, adjustable pattern nozzle is the best choice because it will produce the maximum impact for any given flow by operating at or near optimum nozzle pressure of 100 psi, and has the obvious advantage of pattern control and selection.

Chart "D"



REACTION FORCE OF VARIOUS NOZZLES