TAKE THE SMOOTH BORE TEST

Rod Carringer, *Captain, Training Division, Center Township Fire*
Vice President, Sales and Marketing, Task Force Tips Inc.

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. During the time a fire 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 design, nozzle adjustment and the condition of the nozzle orifice."

This is an opening statement from an IFSTA Pumping Apparatus Driver/Operator Handbook referencing Fire Hose Nozzles and Flow Rates and clearly summarizes the environmental rules that affect fire streams and their functional characteristics. When testing or evaluating nozzles, the fire service generally measures flow and pressure as its primary yardstick for comparisons. Additionally, much controversy has surfaced recently surrounding the ability of one type of nozzle and fire stream to outperform another. Consider the following excerpts from previous IFSTA manuals, "…for example, it is not possible to obtain a solid stream from a fog stream nozzle.." or "…a solid stream has the ability to reach areas that other streams might not reach …" Sadly much of the currently available comparative data concerning these issues is subjective in nature with little or no evidence to support any claims made.

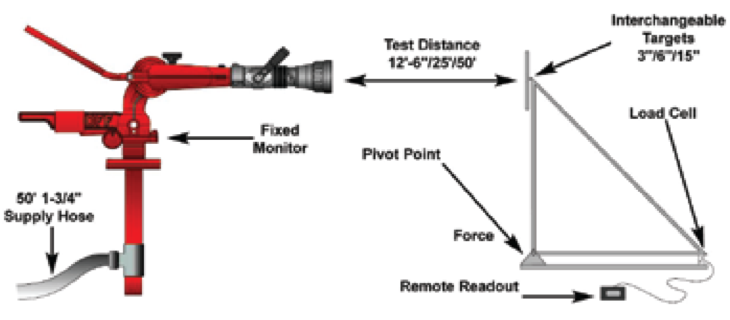
One specific characteristic of a fire stream that has not been measured, until now, is the "hit" or "punch" of a stream. This particular characteristic clearly separates the smooth-bore advocates from those in the adjustable pattern "combination" nozzle camp. Proponents of smooth-bore fire streams claim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

As a result of this controversy, Task Force Tips, Inc. engineered a test method (noted in the diagram) to accurately measure the impact of a fire stream. The device consisted of a test stand that used interchangeable 15", 6", and 3" diameter circular "targets" attached to a vertical member of the test apparatus. A compression load cell was 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 pushed the target and the vertical support transferred the force to the load cell, which in turn, indicated the impact of the stream in lbs/force on a digital readout.

THE TEST SET UP

A flow rate of 160gpm was chosen for comparisons since it represented a typical fire attack. Each nozzle tested 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 and combination nozzles were both operated at 50 and 100 psi at a similar 160 gpm flow rate. This was done to compare the impact of each nozzle at different nozzle pressures (exit velocities). Additionally, by comparing the impact with different types of nozzles at the same flow and pressure, the performance capability of one type over another could be easily determined. A 7/8" smooth-bore was used to deliver 160 gpm at 50 psi, and a ¾" smooth-bore was used to deliver 166 gpm at 100 psi. Three individual TFT automatic handline nozzles were chose to supply 160 gpm at 50 psi, 75 psi, and 100 psi respectively.

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 combination 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 ½" fixed monitor was used. This assured accurate readings by keeping the nozzle stationary once water was flowing and eliminated error caused by holding the nozzle by hand. The monitor was fed with a 50' section of 1 ¾" hose. The pump used was a Hale 1000 gpm model, and all flows were verified using a calibrated electro-magnetic flow meter cross referenced with pitot readings on the smooth-bore nozzles. The flow meter data was collected using a 30-channel chart recorder. One set of tests were undertaken at each distance (12'-6", 25', and 50') with the five different nozzles and yielded a total of 15 sets of data. Each test was run approximately 3 minutes to ensure sufficient data was collected to average the results.

THE TESTS

The first series of tests used a 3" target at a distance 12'-6" (Chart A). At that distance there was very little difference in the impact from either the smooth-bore tip or the combination nozzle operating at 50 psi. At 100 psi nozzle pressure at the same distance, the combination nozzle developed 10% more impact than its smooth-bore counterpart at the same 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 are very close to the reaction forces for that type of nozzle operating at that flow and pressure.

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' and the target was increased to 6". Again, either at 50 psi nozzle pressure or 100 psi nozzle pressure, there is no noticeable difference in impact for the either the combination nozzle or the smooth-bore tip. The 75 psi nozzle again performed as expected; with impact forces between the tests for high and low pressure nozzles at this distance.

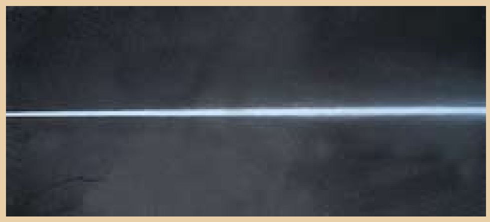
In the third series of tests, (Chart C) the target was moved to a distance of 50' and the target was again increased in size to 15" to compensate for the additional distance. At the 50-foot range, the combination nozzle developed a slightly greater (5%) impact force than the smooth-bore nozzles at either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

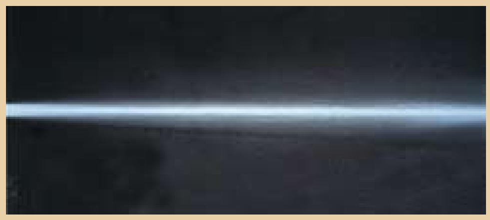
THE CONCLUSIONS

Referring to the bar graphs of each series of tests, (Chart D) it is obvious that there is little difference between the "punch" and "hit" of a fire stream based on the type of nozzle that the fire streams exits from. Rather, the impact ("punch/hit") is more a function of the velocity of a fire stream (pressure) and its mass (flow). 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 combination nozzle when it comes to impact capability. Conversely, if the impact forces of the two nozzles are similar, then the combination nozzle is preferable due to its ability to vary the pattern to meet the needs of the firefighting team. If the best of both worlds is desired, an automatic combination nozzle is the best choice to provide maximum impact for any given flow at 100 psi, and has the obvious advantage of pattern control and selection.

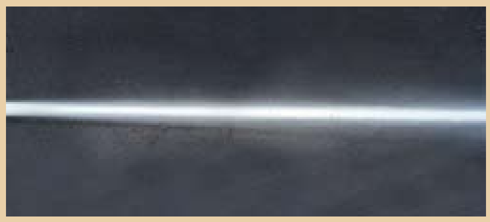
Can You Match The Water Stream With The Nozzle That Produced It?

MidMatic LP flowing 160 gpm @ 55 psi
7/8" Smoothbore flowing 166 gpm @ 50 psi
ThunderFog Selectalbe flowing 155 gpm @ 100 psi
MidMatic LP flowing 160 gpm @ 75 psi
Mid-Force flowing 160 gpm @ 100 psi

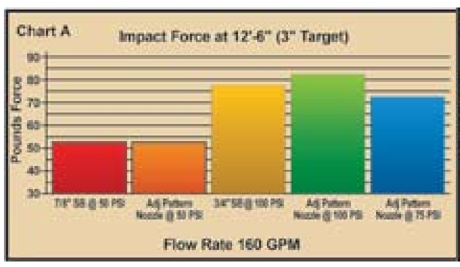
1


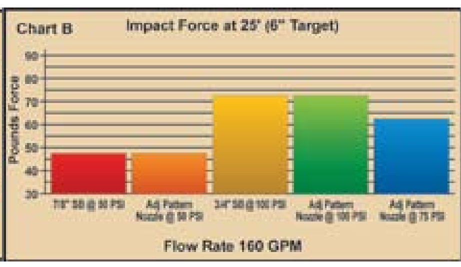
2


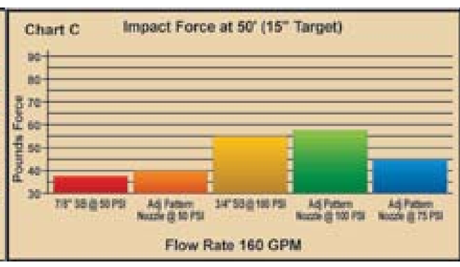
3

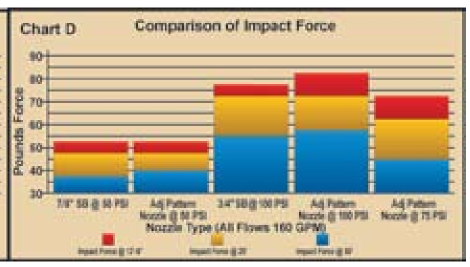

4


5







1 7/8" Smoothbore flowing 166 gpm @ 50 psi
2 MidMatic LP flowing 160 gpm @ 75 psi
3 MidMatic LP flowing 160 gpm @ 55 psi
4 Mid-Force flowing 160 gpm @ 100 psi
5 ThunderFog Selectalbe flowing 155 gpm @ 100 psi