FIRE SERVICE WARRIOR

The 2 ½” Handline: Gaining Relative Superiority

By: Brian Brush

The theory of relative superiority is a foundation of special operations. It comes to us from Admiral William McRaven, Commander of the United States Special Operations Command. In 1995, then Commander, McRaven published *Spec Ops Case Studies in Special Operations Warfare: Theory and Practice.* In *Spec Ops* McRaven defines relative superiority as, "a condition that exists when a smaller attacking force gains a decisive advantage and control over a larger, defending enemy. Once relative superiority is achieved the attacking force is no longer at a disadvantage and has the initiative to exploit the enemy's weakness and secure victory."(1) The following bullet points are taken from Admiral McRaven's book and present numerous parallels to today's fire service. In general we have referred to these connections and fireground operations before at Fire Service Warrior, but today we draw direct connections to the 2 ½" handline and utilizing a hit and move attack technique:

- The defensive form of warfare is intrinsically stronger than the offense. How can a special operations force that has inferior numbers and the disadvantage of attacking the stronger form of warfare gain superiority over the enemy? To understand this paradox is to understand special operations.
- A successful special operation defies conventional wisdom by using a small force to defeat a much larger or well entrenched opponent.
- A special operation is conducted by forces specially trained, equipped and supported for a specific target whose, destruction, elimination or rescue is imperative.
- The key to special operations is to gain relative superiority early in the engagement. The longer an engagement continues, the more likely the outcome will be affected by the will of the enemy, chance or uncertainty.
- Relative superiority favors small forces. Because of their size, it is difficult for large forces to develop a simple plan, keep their movements concealed, conduct detailed full dress rehearsals, gain tactical surprise and speed on target and motivate all the soldiers in the unit to a single goal.

It is rare for an entire alarm (large force) to arrive on the fire scene simultaneously at the onset of an incident. Differences in turn-out times, station location, traffic, or even internal motivation (frictions and complexities) all detract from, or contribute to, the speed at which we deploy. More commonly we see single engines, trucks, or rescues which are "small attacking forces" arriving "early in the engagement" to battle a "much larger or well entrenched opponent." The "longer the engagement continues" the more likely we will become reliant on increasing our numbers as the "outcome will be affected by the will of the enemy." If the first-due companies expect to make an immediate difference on advanced fire conditions, we must strive to achieve relative superiority. "Gain relative superiority through the use of a simple plan, carefully concealed, repeatedly and realistically rehearsed and executed with surprise, speed and purpose."(2)

SMALL FORCES

We must face the fact that the majority of the American fire service firefighting forces have been reduced to our lowest denominator, two. A three-person engine is far and away the most common firefighting unit in the country. On paper this appears appropriate—an officer, engineer and firefighter. In terms of staffing, however, the real-world translation at a working fire is pump operator and two firefighters. In terms of operations, the real-world translation is one line in service. When this is discovered by organizations many will use this perceived staffing deficiency to explain away their ability to place anything other than a 1 ¾" into service. The misconception is that the 2 ½" always requires more people or is more complicated to operate; in many situations this is not true.

Operating as a 1 ¾"-only department is a choice. Operating as a one-line engine is a result of staffing deficiencies. These two considerations are independent. If you fail to prepare for the time when the fire exceeds your company's single weapon (1 ¾") you are effectively conceeding victory to the fire until you can bring a larger force. "An inherent weakness in special forces is their lack of firepower."(3) This statement is true relative to a conventional force (full alarm). Do not accept the fact that you are out-gunned without attempting to bring all your weapons to bear.

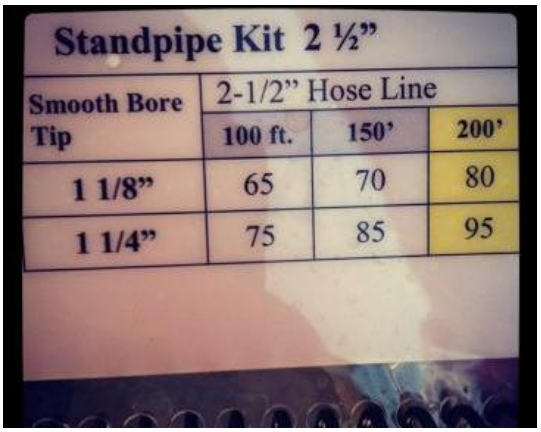
Seek to gain relative superiority. The delay of waiting for more resources to arrive allows the fire to take greater possession of the structure, fortifying its defensive position. The arrival of the larger force there are increases in: the communications needed in scene coordination, reflex time, and numerous other frictions inherent to a more complex operation.

While the 2 ½" handline is a larger line, it is still a single line. Through training, education, and proper tool selection your single-line engine company can effectively deploy and initiate an attack with the bigger weapon. Remember, "the key to special operations is to gain relative superiority early in the engagement." As more resources arrive, your firefighting force is increased and the attack is supported with them joining the simple plan already set in motion, with "the initiative to exploit the enemy's weakness and secure victory."

THE LINE

The 2 ½" hose is "the line" of the modern fire service. In the early 20th century when the fire service became mechanized, 2 ½" and 3" lines were the choice for most departments. The simplicity went beyond having a single hose purchase for attack and supply. The 2 ½" and 3" hose has desirable qualities of high volume flow and low friction loss. When paired with smooth bore nozzles (almost exclusively used in the early 1900s) firefighters had in their hands a quality stream with good reach in spite of the pressure challenges of early pump technology and limited water-supply infrastructure.

When we research for examples of how the 2 ½" line has been favored throughout modern history we look no further than NFPA 14, Standard for Installation of Standpipe and Hose Systems. Originally adopted by the association in 1915, the standard only saw minor revisions and updates until 1993. The tragedy of the One Meridian Plaza fire in Philadelphia, Pennsylvania on February 23, 1991 revealed the disparity between technological advances in equipment being used by fire departments and the dated requirements of the NFPA Standard that the construction industry was designing to. With the One Meridian Fire serving as a catalyst, in 1993 the NFPA overhauled the standard to increase outlet pressures in standpipe systems to better meet demands of 1 ¾" hose and fog nozzles. While the intent of this change was deeply rooted in protecting firefighters it began to erode the all-important simplicity of the previous standard.



Standpipe Kit 2 ½"			
Smooth Bore Tip	2-1/2" Hose Line		
	100 ft.	150'	200'
1 1/8"	65	70	80
1 1/4"	75	85	95

Prior to 1993 the required outlet pressure for standpipe systems was 65 PSI. The reasoning was sound and simple, not dated. 100 feet of 2 ½" hose, flowing 250 gallons per minute through a 1 1/8" smooth bore nozzle has a friction loss of 12 psi per hundred feet and nozzle pressure of 50 psi. Taking 62 and rounding up brings us to 65 psi. Rather than changing the standard to allow for the use of more complex equipment and systems—1 ¾" hose and fog nozzles with higher pressure and more working parts—the modification should have been to raise the outlet pressure to 80 psi to match the modern firefighting tactic of working from the floor below, simply increasing our length.

The importance of the 2 ½" handline cannot be overstated. The reason it stood as the standard for an attack off of a standpipe for nearly 80 years, and has seen an exponential resurgence in use, is because it favors the smaller forces. When we are battling a larger or "more entrenched" enemy (greater than a single-line fire, or those which increase reflex time), the simplicity and efficiency of the 2 ½" handline establish it clearly as the weapon of choice.

THE NOZZLE

Open and closed may be the running joke of nozzle firefighter training; however, the small forces we are operating with increase everyone's roles and responsibilities. The nozzle firefighter is tasked with hose advancement and many times functioning as his own back up. The officer that arrived on the three-person engine is now the supervisor, back up firefighter, and door man. To that note we must ensure that the tools we use maximize the abilities of these operators. Nozzle reaction is the determining factor. Nozzle reaction forces are based on Newton's first law of motion, that for every action there is an equal and opposite reaction. In fire streams this equal and opposite reaction is dictated by the volume of water leaving the nozzle and the pressure at which that water leaves the nozzle. In order to change the reaction force we must either change our GPM output, the nozzle pressure, or both. When we make the decision to place a larger line into service we are making a statement that greater volume is required. This eliminates the choice for us to reduce GPM in order to provide a more manageable line so we must decrease the operating pressure.

The calculations from Elkhart Brass below show the difference that pressure makes. If we choose the common flow of 250 GPM for the 2 ½" inch handline and proceed through the calculation for a fog nozzle at 100 PSI the nozzle reaction is
126lbs.

<u>Fog Nozzle Reaction</u> NR = 0.0505 x Q x √P
NR (Nozzle Reaction)
Q= Gallons Per Minute
P = Nozzle Pressure

When we use the same 250 GPM for the smooth bore calculation with a 1 1/8" tip and 50 PSI nozzle pressure we end up with a nozzle reaction of 99lbs. This is a significant reduction in workload for the nozzle firefighter without compromising the volume.

<u>Solid Bore Nozzle Reaction</u> NR = 1.57 x D2 x P
NR (Nozzle Reaction)
D = Diameter of tip
P = Nozzle Pressure

OPERATIONS
When we are working with the larger line and fewer firefighters, attention to detail and practice are paramount. You can get away with certain mistakes when handling the 1 ¾" handline; however the 2 1/2" is much less forgiving. Good mechanics, fundamental skills and thorough understanding are force multipliers. "In the preparation phase, repetition, like routine, is indispensable in eliminating the barriers to success."(4)

There are numerous resources and methods available on the advancement of the 2 ½" handline. Currently one of the most dedicated practitioners and instructors of hoseline advancement is Aaron Fields with Nozzle Forward. Some of Aaron's and his associates' most popular work is the way they teach advancing lines while flowing. The attention to detail in body positioning and coordinated movements makes the seemingly impossible, possible. With good form and teamwork, a high volume stream is advanced to the fire compartment in complete control and without interruption. I know through trying, as Aaron explains, that mastering those techniques is difficult to do simply watching YouTube videos. It takes direct instruction and more importantly a lot of practice.

Another method of small force attack with the 2 ½" is to hit and move. The hit and move method is less coordinated movement and more of an attack process; set up, flow, advance, repeat. The method utilizes high volume flow, stream reach, and the low nozzle reaction of the 1 1/8" smooth bore and 2 1/2"' line to allow a single firefighter to effectively "lay down cover" prior to each advancement. Consider the numbers. With this weapon we are throwing 250 gallons per minute 30 to 50 feet into an enclosed structure. Flowing this line for 30 to 60 seconds suppresses a significant amount of fire and heat. A situation where a pause for advancement and set up is not created would be rare, but if it should occur the solution is simple. Hold your position and open the nozzle back up. I have found that using the hit and move method, a team of two firefighters can effectively and rapidly mount a forward attack with the larger caliber line.

HIT AND MOVE

It should be understood, but bears repeating, the 2 ½" handline is not the right line for every occasion, especially in limited-staffing situations. With that said we must face our reality. Our cries for more staffing are not unheard, they are just falling on empty wallets and task-overloaded local governments. We must be adaptive and find ways to gain relative superiority or we relegate ourselves to that inherent weakness: lack of fire power. For the balance of this piece I will focus on the hit and move, ground-level advance of the 2 ½" handline with two firefighters. This method will assist small forces with effectively battling or initiating an operation on advanced fire conditions.

Set up, flow, advance, repeat. This will be the cadence of our attack. In our first series of photographs the process is initiated on the exterior. The line is deployed and set up for initial attack. I created two loops of hose, with the advancing line always lying over the top. This short section where the line is off the ground reduces some drag friction and work on the firefighter in the advance. You can also see that I have positioned the first coupling at the doorway. This provides a good point of reference and a solid point to grab as you bring that coupling into the structure preventing the potential hang up on the door jamb.

With the hose set up it is now time to grab the nozzle and work on my positioning. I bring the nozzle out in front of the center of my body with the bale at arm's reach. I pinch the hose between my armpit and my thigh as I bring my back leg up. With my foot solid I roll my body on to the hose and lock my elbow in my inner thigh just above my knee. The ground work is now set and the nozzle opened. The reaction force comes into the core of the body and is distributed across the foundation. Due to the arm's length of hose out in front, small movements at the base are amplified over the distance and the nozzle can be "whipped" around with ease. From this position you attack until you have determined the knockdown permits a safe advance and you move in, taking the nozzle forward by the bale and the line forward at the coupling.

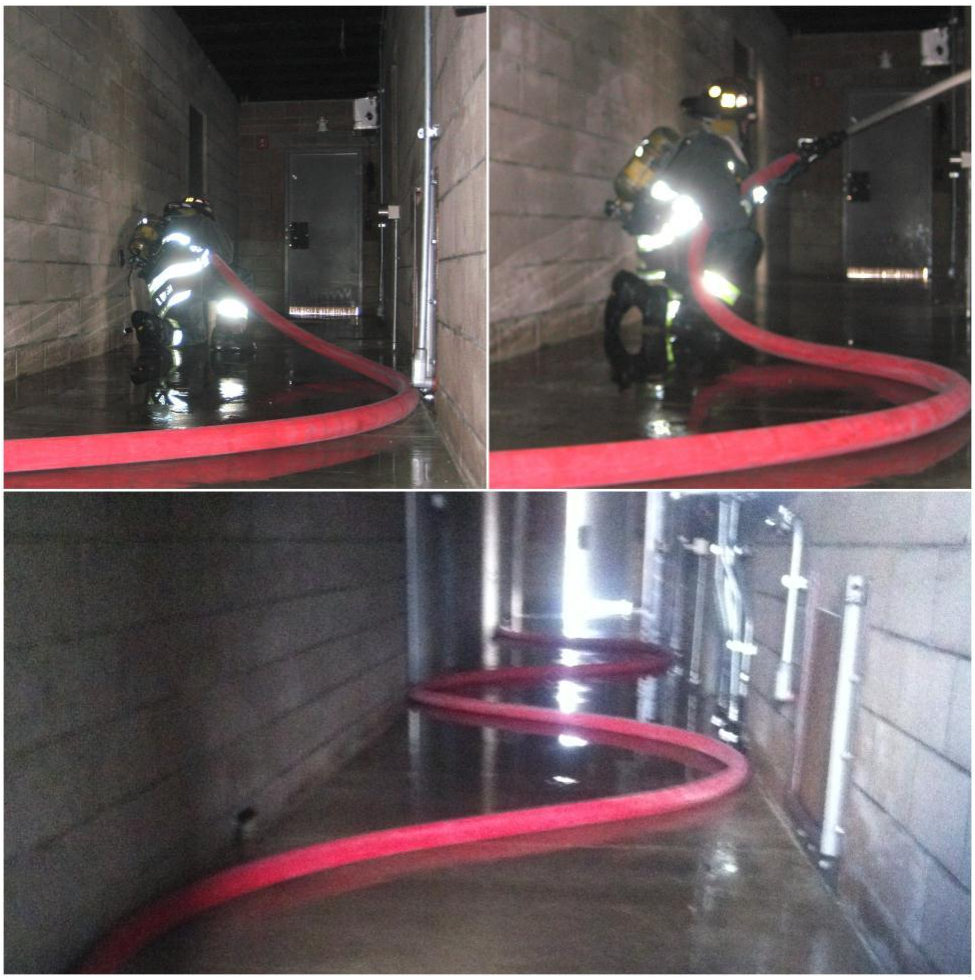
Set up, flow, advance, and now we move in. In this structure the exterior door brings us into the stairwell before making the interior hallway. This shortens our initial push as we only move a few feet into the structure from the exterior before we set up again. The important note is that this is not a sprint to the fire room, this is a calculated advance. We must take advantage of points of cover as we progress forward. The setup is very similar to the exterior—the coupling and nozzle are brought forward to the door and threshold. I take up the nozzle with sufficient hose in front and the elbow is locked in front of the raised knee, pinching down on the line. You can see that the body is square to the stream, however the stream is being manipulated in a clockwise fashion.

Also note that the stream is running the full length of the hallway and has blown open the opposite door.

Set up, flow, and advance for making the interior. Once you have cleared the potential hang-ups of the initial doorways and thresholds with the coupling, the focus of the nozzle firefighter now becomes the advancement of his nozzle, and hose-movement duties fall to the second firefighter. Once again, when you have determined you have knocked back enough fire and heat to advance the flow is shut down and you advance, dragging the hose forward by the bale as it is fed in by the second firefighter. Once you reach the point where you want to set up, set the nozzle down, fall back down the line to that arm's reach and establish the body position to flow again.

While the nozzle firefighter has established his first position on the interior and begins to flow, the back up firefighter starts to stock hose for the next push. This can be done by making loops in an open area like a foyer or room. In a hallway, hose can be stocked by creating an S. The S from wall to wall stocks hose so that when the next advance is made the natural desire of the hose to straighten, assisting the advancement of the hose. In this series of pictures you can see that the S in the hallway is straightened on the advance and the nozzle is moved forward into the fire room about 10 feet. For the nozzle firefighter the S of the hose creates greater friction with the ground in his immediate area while flowing. This helps take the nozzle reaction to the ground across a broader area. If the line is straight behind the nozzle firefighter it has greater tendency to "cheat back" on him.

Once the S is well established and the back-up firefighter is in position to feed hose, the nozzle firefighter should have an easier advance on his next move and he may be able to maintain the line in his armpit as he pushes to his next attack point.



The hallway also provides an added benefit of support. As the nozzle firefighter begins to fatigue on the advance he can lean into, or set up against, a wall to use the surface to counter nozzle reaction forces. Another method shown below is to run the hose between the legs and use a foot to pin it to the wall contrary to the armpit-lock method required when working in an open area.

One other alternative method to present is the knee-on-the-hose technique. This method is the easiest way for a single firefighter to flow a larger caliber line. The method favors smaller firefighters who struggle with the weight of the charged line or nozzle reaction, or firefighters who are getting fatigued by the work and advance. It is also a great method for use in an open-floor or exterior attack where a wall is not present to support. We are all familiar with the "sit on the loop" method of a single firefighter 2 ½" flow. However, sitting on hose is a passive position and stationary. The knee-on-the-hose has a forward focus. Shut down and advance with a straight drag very quickly, then by taking the nozzle reaction straight to the ground with your body weight on the knee, the work load on the firefighter is minimized.

Advance to your point of set up and drop back on the line until you are arm's reach from the bale. But rather than lift the hose into your armpit, place a knee on the hose and raise the nozzle to about a 45-degree position. When you open the bale drop one hand back to the knee and split the distance with the other. This leaves the bale fully open to operate and allows for great play, or "whip," in the line with minimal movements back at the foundation.

MAKING THE TURN

Set up, flow, advance, set up, flow, advance, set up, flow, advance. You are now at the final push, ready to make the turn. Your exhausted, but in control. You have battled the fire back and as the line continues to knock it down you start to review the plan for your last move. You have great position. Looking behind you down the line you see your back up has stocked you with enough hose to make the final push. He starts moving up the line to support you and fight together through the last doorway.

A surge of energy hits you, the ground swell that develops when the underdog has the lead in the final seconds of the game. You are David and Goliath is teetering. The small force has gained relative superiority and the paradox of special operations is realized. The hours of training, the study of the playbook, and the proper weapon selection became force multipliers. This coupled with the simplicity and speed of a small team and victory is achieved over a larger, more entrenched enemy with thousands of years of experience in taking lives and destroying property.

You do not accomplish anything with a plan alone; it only serves as a guide to action. If you wish to gain relative superiority with your single-line engine company you must make the turn and take these ideas; test, repeat, modify and prove them. When that process is done you must seek to refine in a continuous and tireless forward progression.

Notes 1 – 4: Spec Ops Case Studies in Special Operations Warfare: Theory and Practice. 1995.