Flowing-and-Moving

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The introduction and evolution of SCBA and turnout gear has dramatically influenced firefighting operations. These advancements have proven to be a "double-edged sword." Because of the increased protection, firefighters are able to penetrate deeper and faster without continuously flowing water. They are no longer solely dependent on the cooling effect of the stream or the additional fresh air it entrains to "breathe off the nozzle." As a result, the fire service largely deviated from the flow-and-move approach. This gave way to the misapplication and overreliance on the hit-and-move advance, leading to a deterioration or even the complete loss of the previous skillset. By charging in as close to the seat of the fire as possible, without the timely and sufficient application of water, the thermal insult to the firefighters is increased, putting themselves at a greater risk of rapid fire spread/flashover and burn injuries. More significantly, they are delaying the unprotected victims the relief they so desperately need to survive. Just because firefighters have operated in this manner without experiencing any casualties, creating success/confirmation biases, does not mean it was the most effective or efficient means of extinguishment. The driving force behind our decision-making must remain what is best for the survivability of any trapped occupants, *period*.

After opening the access door, "staying low and letting it blow," use that time as a tactical pause to assess the conditions. If the neutral plane is at or below the height of the doorknob and the smoke is dark and exhausting at a moderate to fast speed, especially when black and turbulent, the attack should begin from the entryway. Those conditions indicate the fire is nearby and will arrive at the point of entry in short order, *if left unchecked*.

When the fire is remote from the point of entry (e.g., a bedroom off of a hallway), the nozzle team should capitalize on any visibility at the floor-level, which can be enhanced by the air exchange occurring at the doorway, and advance through the intermediate area—the travel lane—until they are in position to initiate the attack. Using a bedroom fire in ranch-style private-dwelling as an example, the travel lane would be from the point of entry—the front door—to the junction point of the hallway. Suppression would then begin from that point, as the nozzle team is now "on the approach"—the final 10-15-feet leading to the seat of the fire, the attack lane. Doing so leverages the full power of the stream to take and maintain control of the space. The effective reach of a 1¾-inch stream in a superheated environment is roughly 25- to 30-feet – enough to clear any compartment in a typical dwelling. If the fire is located in a space adjacent to the point of entry (e.g., the kitchen or dining room), *there will be no travel lane*. Because the nozzle team is entering directly into the attack lane, suppression should begin as they cross the threshold. In either case, ventilation would be requested just prior to initiating the push, under ideal circumstances.

Because of the high synthetic fuel load and the predominately ventilation-limited conditions encountered, fire in the overhead can be concealed by the volume of thick, dark smoke that is produced as a result. Firefighters can no longer rely *solely* on the tell-tale visual cue of rollover, which is an imminent precursor to flashover. Furthermore, with firefighters' bodies fully encapsulated, their tactile recognition is also greatly impaired. The degree of thermal protection afforded by modern turnout gear requires a considerable amount of heat to permeate it and reach the skin – allowing firefighters to unknowingly crawl into an environment that desperately needs to be cooled. Firefighters cannot wait until discomfort is experienced to open the nozzle…and more importantly, *neither can the unprotected victims*.

To make up for this diminished acuity of our senses, firefighters must take advantage of the insights provided by thermal imagers. It is critical to understand, however, that thermal imagers merely provide a "pictorial representation of heat," based on the relative temperature of the objects within their field of view. Correctly using the thermal imager and accurately interpreting the image on the screen requires an understanding of how the device works and what to specifically look for. A skilled operator can readily identify the thermal balance, as well as the thermal currents and evaluate their velocity, to not only determine the direction of the fire, but also to aid in gauging their proximity to it. The lower the height of the thermal balance and the faster the thermal currents are moving, the more (heat) energy is present and the closer you are to the seat of the fire. If no thermal currents are readily observed, the fire is likely confined by a closed door.

Thermal imagers have their limitations and are not infallible. It must be understood thermal imagers are not reliable thermometers. The density of the smoke can develop to the extent that the spot temperature reading is actually based on the thermal imager's penetration depth within the smoke. This variance can provide a skewed assessment of the environment – producing readings that are off by as much as 450°F less than the actual temperature of the object being targeted. For this reason, the spot temperature reading feature has been removed from the basic firefighting mode in the latest edition of NFPA 1801: *Standard on Thermal Imagers for the Fire Service*. Tactical decisions, therefore, should not be based on the spot temperature reading alone.

If operating in zero or low visibility conditions, and high-velocity thermal currents are being observed through the thermal imager, embers are falling down from the overhead, loud snapping, crackling, and popping noises are heard, and/or heat is being physically experienced, regardless if any fire (including rollover) can be seen, open the nozzle and flow-and-move from that point (in the direction of the movement/sound/sensation), as you are within the attack lane and *the space is in immediate need of cooling*. There are also times when operating in a zero to low visibility environment where those warning signs are not apparent, but something just does not feel right. When you are unsure as to the boundaries of the fire and you want an "insurance policy" or you have an uneasy ("gut") feeling, trust your intuitions. *When in doubt, open the nozzle; that should be your default response*.

If the nozzle has to be shut down because of the terrain (e.g., clutter/hoarding conditions or otherwise tight quarters), high nozzle pressure, or for any other reason, the hits should be long and thorough—maximizing the stream reach and water mapping (i.e., its distribution throughout the space)—and the intermittent movements should be short and fast, being ever-mindful of the conditions while doing so. This hit-and-move approach should only be conducted as needed, transitioning into a flow-and-move advance as soon as possible (unless the fire is knocked down by the initial hit). It is important to note that conditions can immediately rebound as soon as the nozzle is shut down if base water application is not being achieved. When the stream is not reaching the seat of the fire it is only knocking-back the flame front, addressing the burning gases and not the surface fuels—the actual source. This method of attack is temporarily stunting the fire, which is merely "renting" the space ahead. Progress is given up each time the bale is closed to move forward, which must then be recaptured; "bunny-hopping" to the seat of the fire. Flowing-and-moving, on the other hand, maintains the progress gained, "owning" the space throughout the advance; a "positive-capture" fire attack. Because of its suppressive efficiency, flowing-and-moving has been proven to result in a faster knockdown with less cumulative water usage than a hit-and-move approach under the same circumstances.

When the nozzle is first opened, applying the stream *into the overhead*, using a side-to-side or "zig-zag" pattern (moving in a wall-ceiling-wall sequence), it will pass through the hot upper-layer, cooling the superheated gases and causing them to contract. The stream will largely ride across the ceiling and cascade down as it fans out and impacts the walls, coating and cooling those surfaces. The stream should then be lowered downrange and transition into an "O-pattern" for the actual push; honing in on the threshold to the seat of the fire. Doing so allows the stream to capture the floor, sweeping it of sharp or burning debris and scalding water, as well as (audibly) sounding it for any potential holes. Operating the stream in this manner not only maximizes the water mapping, but also the air entrainment. This increased flow of fresh air—over 5,000 cubic feet per minute at 150 gallons per minute—can seal off the approach corridor and eventually the doorway of the fire room, *regardless of whether the involved area is vented ahead*.

The pressure front created by the air entrained from the handline stream can block the by-products of combustion tracking toward the open entry door, preventing them from exhausting overhead of the nozzle team. Even when a distal opening is not present opposite the nozzle team's advance, steam expansion is not a concern on the approach when effective suppression is taking place. The active cooling and subsequent gas contraction will reduce the pressure at a greater rate than that which is produced as the water expands. The experiments conducted in the FSRI research studies demonstrate "moisture content does not increase drastically during suppression efforts, and therefore, do not increase injuries due to steam for trapped occupants. If the involved area is vented ahead, the pressure front from the flowing-and-moving stream can actually reverse the exhaust—converting the bidirectional flow at that entry doorway into a unidirectional flow. The fresh air intaking from the entry doorway will flow past the nozzle team and through the involved area—driving the by-products out the distal opening ahead; maximizing its exhaust output and the benefits afforded to both the firefighting efforts and victim survivability. As Tacoma Fire Lieutenant Tory Tolefree succinctly stated, "Fire attack is overcoming the pressure and thermal gradient with air and water."

Although visibility ahead of the nozzle team (*if there is any*) will be temporarily lost, as the stream immediately disrupts the smoke layer, it will begin to restore behind them as they advance forward and extinguish the fire. Cooling the environment will cause the gases to contract, and the smoke will start to lift. The by-products of combustion will also be driven away, ideally out an opposing vent opening to accelerate the process. If the fire is well-vented and is providing visibility that is aiding in navigating the terrain and surveying the spaces ahead, opening up the nozzle to initiate the push may be *briefly* delayed, as conditions allow, if a crew is searching the area immediately ahead of the handline. In many cases, however, these operations occur in a zero- or low-visibility environment, where only the glow of the fire may be seen (at most), and therefore, delaying suppression provides no benefit.

Regardless, the average push is only about 10- to 15-feet to the seat of the fire, initiated from the junction point of the hallway or the threshold of the adjoining room. Moving at a steady pace, about one step per second, the nozzle team can reach the fire room within roughly 15 seconds, potentially using as little as about 50 gallons of water during the initial push. In all of the FSRI experiments, less than 100 gallons of water total was used to knockdown a one-bedroom fire, and less than 250 gallons for a two-bedroom fire. Flowing-and-moving leverages the power of the handline's stream to overcome the fire and its by-products. By taking control of the space on the approach, you are confining the fire and reducing the thermal and toxic threat, particularly for the unprotected victims. The application of water and the additional flow of air will profoundly impact the conditions along the intake pathway. The increase in oxygen concentration, as well as the decrease in fire gas concentrations and temperatures, will greatly enhance fireground operations and victim survivability, especially when there is a vent opposite the advance.

Once the nozzle team arrives at the threshold of the involved area, however, the method of stream application should be tempered, especially when the space is not vented. The stream should be reset—directed overhead into the fire room at the steepest angle. Doing so maximizes water mapping across the ceiling and gas contraction within the hot upper layer, while also minimizing air entrainment within the compartment. The stream should then be worked laterally, from wall-to-wall, and then opened up into a wide O-pattern to capture the surface fuels and the floor, once the fire is darkened down. When advancing into the fire room, be sure to turn and hit the back wall—the wall which the doorway is framed within, as the stream will not have reached that surface or any of the fuels along it on the initial hit.

Despite its long-standing tradition and proven effectiveness, both anecdotal/experiential and now scientific, there are still firefighters who question or even dispute the practicality of the flow-and-move advance. A great deal of the skepticism and arguments stem from its purpose and application being misconstrued. Although many well-intentioned firefighters attempt to advocate for flowing-and-moving, they unfortunately do so by focusing on the "how;" most often demonstrating the technique in the unrealistic environment of an open parking lot and at an unreasonable pace. The heart of this discussion, however, lies within the "when," "where," and, most importantly, the "why," which should be the starting point of the conversation.

For its value to be understood and appreciated, an explanation must be provided as to the impact it has on the environment, how it benefits the fire attack and the search effort, and any trapped occupants, as well as the specific parameters for its use. Without this critical background, there is no context or intent and, in turn, the message can be misinterpreted that flowing-and-moving is being advocated for as the only means of operating. What we must convey is that not every fire will require a full 10- to 15-foot flow-and-move advance to reach the seat of the fire, nor will the push always be initiated from the point of entry. The decision to implement this method is dictated by the conditions encountered and, most significantly, what will best support the firefighting operations and victim survivability.

The flow-and-move approach is most commonly attributed to the following scenarios:

- An offset room that is post-flashover with fire extending out
- Multiple rooms involved in fire
- A wind-impacted condition, where the handline is advancing from the downwind side
- A below-grade fire, where the handline is advancing down the interior stairs from above
- A fire that is venting out or extending towards the point of entry

Because many of these situations are not the basic "bread-and-butter" room-and-contents fires, firefighters may balk at the need to flow-and-move if they have yet to encounter any of those situations personally. The problem is that the fireground is not the time or the place to have that epiphany moment. Often, there is little margin for error in these instances, which require decisive and swift action. The ability to flow-and-move can be the difference between you making the push *or the fire pushing you out*.

A continuous size-up to read the conditions and anticipate their progression is imperative to the initial selection of the fire attack method, as well as the need for any modification throughout its execution. As with anything else on the fireground, critical-thinking and commonsense must prevail. If you can see your feet, walk as you move in. If you cannot, crouch down until you can, or drop down to the floor and move in a “tripod” position. Whenever there is visibility at the floor level, take advantage of it and briefly scan the area for potential victims, the fire, and the general layout of the space prior to moving in and opening up; as the disruption of the smoke layer will temporarily obscure your vision once the stream is applied. When that “clean space” is not present, open the nozzle as soon as you enter the attack lane and are on the approach, or the conditions otherwise warrant it. It cannot be emphasized enough that achieving knockdown requires base water application. When the stream is not reaching the seat of the fire, it is only momentarily knocking-back the burning fire gases, and conditions will begin to rebound as soon as the nozzle is shut-down. If this occurs, the nozzle must be immediately re-opened and should remain that way throughout the advance until the fire is knocked-down.

There still exists an apprehension among many firefighters to continuously flow water, if no fire is visible, even when encountering an appreciable heat condition. Much of this problem can be linked to the negative habits and assumptions inadvertently spawned out of live fire training. Because the instruction in these evolutions has historically been to advance in as close to the fire as possible, allowing for the greatest amount of heat and fire to be experienced, coupled with the flawed mantra of “do not flow water on smoke” that was professed for so many years, firefighters were programmed to advance all the way to the seat of the fire without flowing water, regardless of the circumstances. Another issue derived from live fire training is the common practice of restricting the suppression to only short bursts of water, known as “penciling,” to avoid completely extinguishing the fire so it can be quickly reset for the next evolution, which can be harshly reinforced by the instructors or burn tenders. As the burn building itself becomes saturated with heat, the insufficient application of water can result in excess steam production, banking down on top of the firefighters.

These experiences create “training scars,” which can lead firefighters to become hesitant to flow water. In reality, when the necessary volume of water is properly applied, the rate the fire gases contract as they are cooled by the stream (causing an immediate reduction in pressure) can exceed the rate at which the water will expand as it absorbs the heat. Unlike the thick concrete or steel walls and ceilings of a burn building, which eventually become saturated with heat and begin projecting it back out (i.e., radiation feedback), the surfaces within most residential wood-frame structures will, instead, be cooled more rapidly with less steam production. This misconception regarding steam and “inverting” the thermal layer can be furthered by negative encounters firefighters may have had in the past, where fog streams were used for fire attack. Fire instructors must ensure they are instilling best practices as well as prompting and debriefing firefighters as to the actual conditions they can expect and the impact their tactics will have on the fireground.

The problem of delayed suppression is further reinforced by our PPE, which distorts our perception of the environment and its severity, since discomfort is typically not experienced until the gear starts to become saturated with heat. This can produce a success/confirmation bias each time a fire is extinguished without flowing-and-moving where it was actually warranted. Just because “the fire went out and nobody got hurt” (an inappropriate and cancerous metric often used as an excuse for poor performance) does not mean it was the best course of action. The question we must pose is, “Were the (potentially) trapped occupants given the best chance of survival?" Despite the advancements in technology, affording us the luxury of protection through fully encapsulating turnout gear and SCBA, the victims remain fully exposed to the thermal and toxic threat, which has dramatically increased over the last few decades. We must apply our tactics through the lens of the victim. To drive this point home, Everett (WA) Fire Captain John Tanaka uses the analogy, "Fight fire like you are naked."

Despite the proliferation of phrases such as, "Another tool in the toolbox" and "It's situationally dependent," there is absolutely a hierarchy of effectiveness when it comes to the tactical options at our disposal, and *flowing-and-moving is the gold standard of fire attack*. Maximizing victim survivability and property conservation must remain the basis of our decision-making. Withholding the application of water can be culturally influenced as well. There are organizations where your worth as a firefighter is judged by how deep you can push in and how much heat you can take before opening the nozzle. This bravado not only negligently increases the risk to firefighters, unnecessarily saturating their turnout gear, but compromises the achievement of the overall mission – protecting life and property; allowing the fire to further develop, unchecked, and the tenability to deteriorate.

Engine company firefighters must be well-versed in flowing-and-moving in various settings; as the approach will not always be a straight-forward, unobstructed hallway. They must be capable of advancing forward and backward, up and down stairs (including straight run, return, and circular types), navigating 90° and 180° turns with open- and closed-ended corners, as well as contending with restricted pathways and clutter conditions. In each of these configurations, the nozzle team must be able to make the push in tandem (i.e., married up together and advancing as one unit) and separated (i.e., the nozzle firefighter knee-walking while the backup firefighter provides support a few feet behind). These operations are labor intensive and require finesse, forethought, and teamwork, especially for understaffed engine companies. The associated techniques are nuanced and take proper instruction and continual practice to develop and maintain the proficiency to operate effectively and efficiently.

Sadly, flowing-and-moving is not emphasized or even included in many fire academies. Because people have a tendency to reject or avoid what they are not familiar or comfortable with, this can also be another source of contention regarding its use. Once competent in the proper body mechanics to distribute weight, maximize leverage, and displace (reaction) force, in addition to proactive hose management, however, that daunting task, which may have seemed unreasonable or even impossible to those firefighters, can become not just a reality but one of their greatest assets. Flowing-and-moving enables an engine company to wield the full suppressive power of their handline—overwhelming and outmaneuvering the fire with the superior force of the stream and the advantageous tempo of the nozzle team.

Flowing-and-moving is a matter of life safety for both firefighters and civilians alike. Not only can it restore/preserve the egress pathways and the survivable space, providing cover for the search and rescue operations, but it is also essential if the nozzle team starts to get over-run or outflanked and needs to retreat under fire. For an engine company, the ability to flow-and-move is simply a requisite skill-set. An engine company must be able to operate in any environment and contend with any conditions they may encounter to reach their objective and accomplish their mission—protecting the means of egress to facilitate the search for and removal of any trapped occupants, and ultimately, extinguishing the seat of the fire.

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