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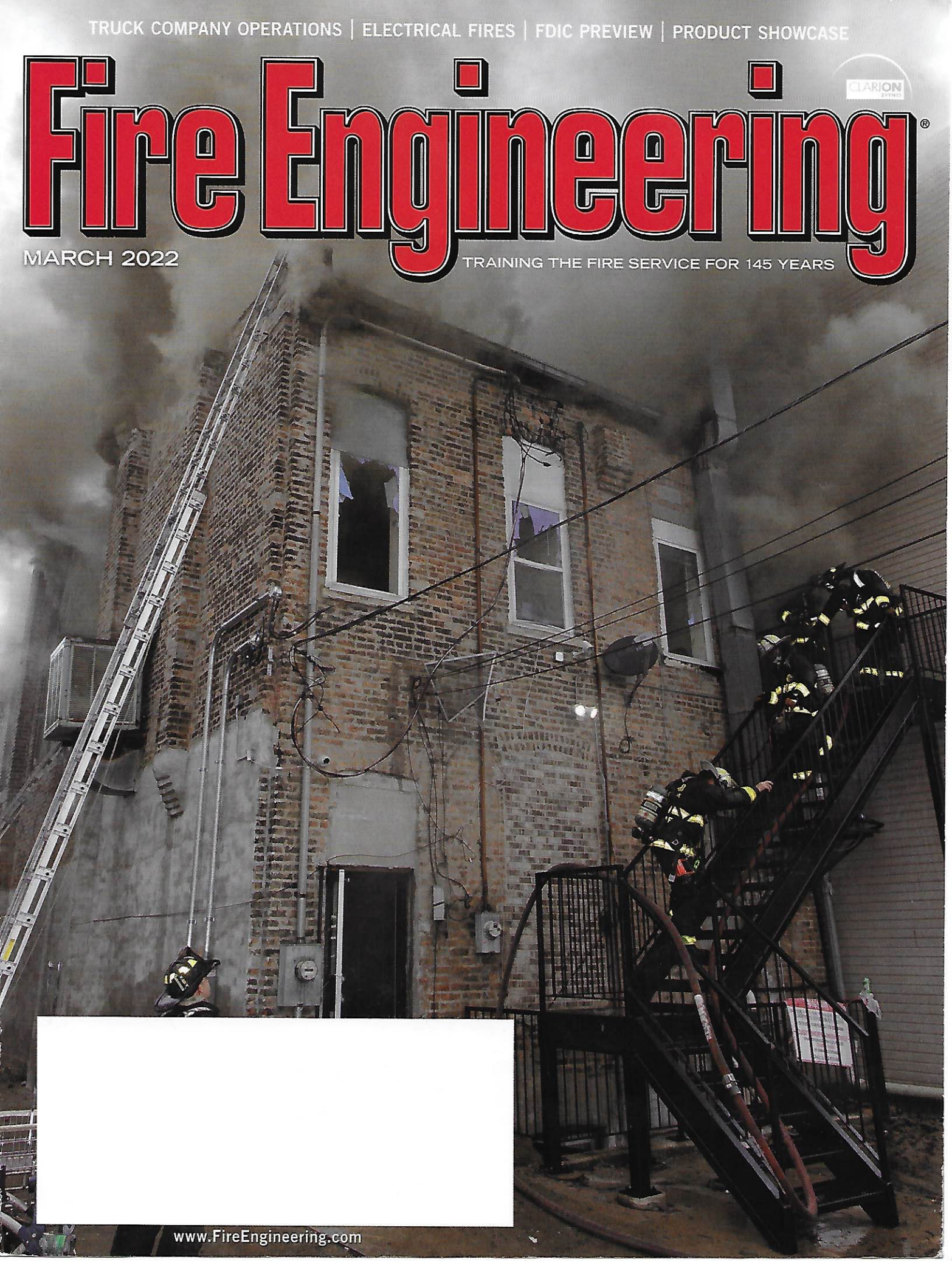

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Leveraging Fire Streams and Ventilation

BY NICHOLAS PAPA

WITH THE FIRE ALWAYS HAVING the "home field advantage" and a head start on us, we are perpetually fighting it at a disadvantage. As fuel loads and the use of synthetic/lightweight materials increase, the deck keeps getting stacked higher and higher against us. There is, however, one "ace" we have up our sleeves that not only can level the playing field but decimate it altogether: the ability to advance on the fire with a flowing and moving handline. This tactic is tried and true, one that our predecessors once relied on almost exclusively because of their lack of self-contained breathing apparatus (SCBA) and the minimal thermal protection their sparse personal protective equipment (PPE) provided, which consisted of only rubber or canvas long coats, rubber pull-up ("three-quarter") boots, and rubber ("Fire Ball") or leather utility gloves.

Flowing and moving were essential for crews to make the push, as they needed the fresh air and relief from the heat that the stream provided. Because they were on a fairly level playing field with the trapped victims they were working to protect/rescue, they were much more attuned to their environment and better understood how to leverage their tactics to maximize their impact and improve the conditions (photo 1).

(1) The fireground is a dynamic environment, and the terrain encountered will present a wide range of obstacles that the engine company must overcome. *(Photo by Michael Carenza Jr.)*

The introduction of SCBA and turnout gear, which has significantly evolved since their inception, has dramatically influenced our operations—a double-edged sword. Because the increased protection allowed us to penetrate deeper without continuously flowing water, we 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 skill set. By charging in farther, without the timely and consistent application of water, we not only dangerously saturate our turnout gear with heat and put ourselves at a greater risk of rapid fire spread/flashover and burn injuries, we also delay the relief that the unprotected victims so desperately need to survive. Just because we can and have operated in this manner does not mean that we always should. The driving force behind our decision making must remain what is best for the survivability of any trapped occupants, period.

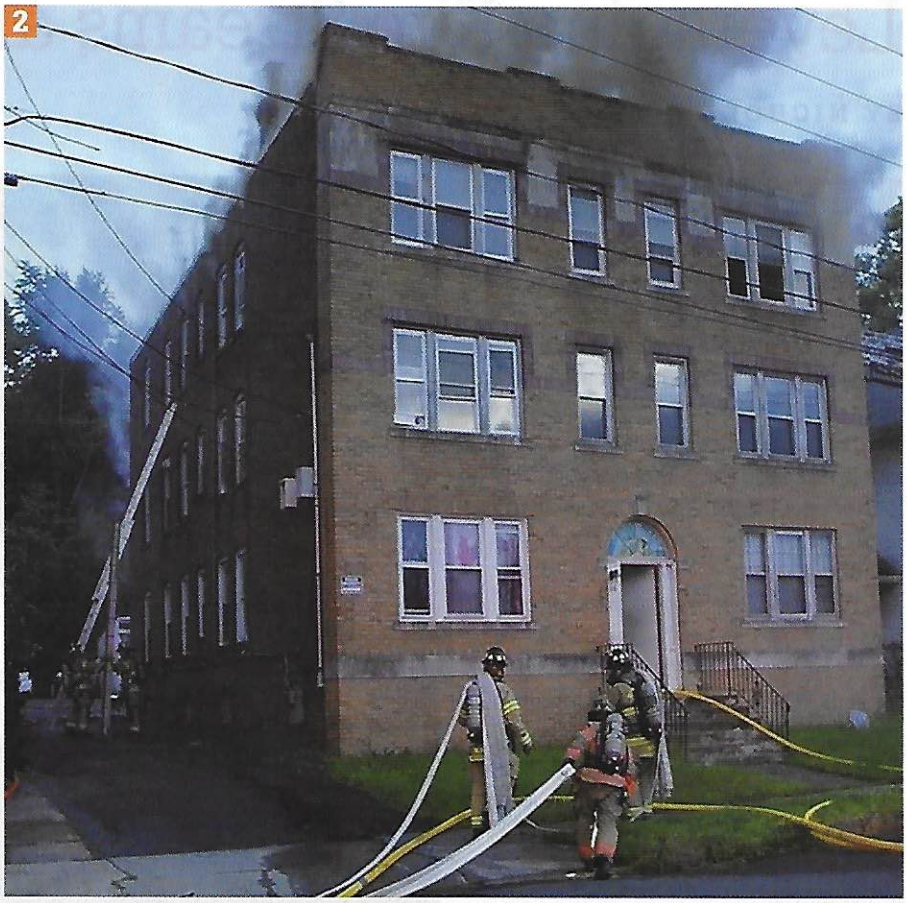
When on the approach to the seat of the fire, open the nozzle as soon as the fire becomes visible, leveraging the power of the stream and taking control of the environment. The effective reach of a 1¾-inch stream in a superheated environment is roughly 25 feet. That distance is enough to clear any room or hallway in a typical residential occupancy. Because of the high synthetic fuel load and the ventilation-limited conditions we frequently encounter, fire in the overhead can be concealed by the large volume of thick, dark smoke produced as a result. We can no longer rely solely on the tell-tale visual cue of rollover, which is an imminent precursor to flashover. Furthermore, with our bodies fully encapsulated, our tactile recognition is also

greatly impaired. The degree of thermal protection afforded by modern turnout gear means that it takes a considerable amount of heat to permeate to the skin, which could allow us to unknowingly crawl into an environment that desperately needs to be cooled. We cannot wait until we feel discomfort to open the nozzle.

To make up for this loss of our senses, we must take advantage of the insights provided by our thermal imaging cameras (TICs). It is critical to understand that TICs merely provide a "pictorial representation of heat" based on the relative temperature of the objects within the field of view of the lens. Using the TIC to its full potential and accurately interpreting the image on the screen, however, require an understanding of how the TIC works and what to look for. A skilled operator can readily identify the thermal currents and evaluate their velocity to not only determine the direction of the fire but aid in gauging his proximity to it. The faster the currents are moving, the more energy (heat) is present, which will increase the closer you get to the fire.

If you are operating in zero- or limited-visibility conditions and are observing high-velocity thermal currents or physically experiencing heat, regardless of if you can see any fire (including rollover), open the nozzle until conditions *sustainably* improve. There are also times in this environment where there may not be any glaring warning signs but something just does not feel right. When you have that "gut feeling," trust your intuition and act accordingly. When in doubt, open the nozzle; that should be your default move. If the nozzle is shut down and must be reopened because of deteriorating conditions, it should remain that way until the seat of the fire has been reached and the fire is put in check.

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. Flowing and moving, however, not only will preserve the progress made throughout the advance, making it a "positive-capture" tactic, but they have been proven to result in a faster knockdown and less cumulative water usage than a hit-and-move approach under the same circumstances.



(2) Signs of extinguishment are visible as the nozzle team makes the final push into the involved unit after advancing down the long hallway. *(Photo by Michael Carenza Jr.)*

When you first open the nozzle, applying the stream into the overhead in a side-to-side or "zig-zag" pattern, it will pass through the hot upper layer, cooling the superheated gases and causing them to contract. The stream will then largely ride across the ceiling and cascade down as it fans out and reaches the walls and, eventually, the floor, coating and cooling those surfaces.

Once you address the immediate area, work the stream around in a tight "O" pattern, focusing on the upper register, and lower it down range, periodically widening the "O" to capture the floor and sweep it of harmful debris and scalding water as well as sounding it for any potential holes. Not only will this maximize the water mapping of the stream (i.e., how well it is being distributed throughout the space), but it will increase the amount of air it entrains as well.

This massive flow of fresh air—5,000 cubic feet per minute at 150 gallons per minute—can create a pressure front and seal off the approach corridor (i.e., the hallway) and eventually the doorway of the fire room. This can block the by-products of combustion from exhausting overhead, tracking toward the open entry door, and increase the intake input through that opening. If the fire room is vented, the flowing and moving stream can even reverse the exhaust path. The air entrainment from the stream can convert the bidirectional flow (intake and exhaust) previously occurring at that entry doorway into a unidirectional flow (full intake), flowing downrange toward the seat of the fire. With a vent point opposite the handline's advance, the reversal can allow the flow of fresh air to extend throughout that pathway and redirect the by-products out that opening, maximizing its output (full exhaust) and the benefits to the firefighting efforts and victim survivability (photo 2).

Although visibility ahead of the nozzle team (if there is any) will be momentarily lost, as the stream immediately disrupts the smoke layer, it will begin to restore as they advance forward and extinguish the fire. By , cooling the environment, causing the gases to contract, the smoke will start to lift. The by-products of combustion will also be driven away, ideally out of an opposing vent opening, which will accelerate the process. If the fire is well-vented and providing visibility that aids in navigating the terrain and surveying the spaces ahead (for any trapped victims), opening the nozzle to initiate the push may be briefly delayed as long as conditions allow, especially if a crew is searching ahead of the handline.

In many cases, the need to flow and move will occur in a zero- or limited-visibility environment, where only the glow of the fire may be seen. Regardless, the average push is only about 10 to 15 feet, typically initiated from a hallway, an adjacent space (e.g., a living room or kitchen), or the point of access if turbulent smoke or fire is venting out the entryway. Moving at a steady pace (about one step per second), the nozzle team will likely reach the fire room in roughly 15 seconds, using less than 50 gallons of water.

Flowing and moving leverage 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 (behind the nozzle) as well as the decrease in fire gas concentrations and temperatures will greatly enhance fireground operations and victim survivability (photo 3).

Despite its long-standing tradition and proven effectiveness, both 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.

(3) The nozzle firefighter leans out of the window to scrub the exterior after flowing and moving were required to knock down the wind-impacted fire in the bedroom. *[Photo courtesy of New Britain (CT) Fire Department (NBFD).]*

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 search effort and any trapped occupants, and 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 are being touted as the only approach to fire attack. What we must convey is that not every fire will require a 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 approach is dictated by the conditions encountered and, most significantly, what will best support the firefighting operations and victim survivability.

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. When opening the door to the fire area, stay low and off to the side and briefly pause to let the smoke blow and lift. Seize this opportunity to observe the presentation and characteristics of the smoke as it discharges. This information will provide you with a better assessment as to the location and severity of the fire and how to approach it. Look for a defined break in the smoke as it exhausts from the opening (the "neutral plane"), allowing fresh air to enter below, intaking toward the fire—an indicator that you are on the same level as the fire. If no neutral plane is present, with the opening serving as a full exhaust, this should be an immediate red flag; the seat of the fire is likely located beneath you or there is a wind-impacted condition, and the door is located on the downwind side of the building. The presence/height of the neutral plane and the volatility of the smoke will determine how you approach the fire.

As with anything else on the fireground, critical thinking and common-sense must prevail. If you can see your feet, walk as you move in. If you cannot, crouch down until you can (e.g., "duck walk") or drop down to the floor and

move in a "tripod" position. Whenever there is visibility at the floor level, take advantage of this and briefly scan the area for potential victims, the fire, and the general layout of the space prior to moving in and opening up; the disruption in the smoke layer will temporarily obscure your vision once you apply the stream. When that "clean space" is not present, open the nozzle as soon as the fire becomes visible or the conditions otherwise warrant it. Continue to operate the nozzle until you experience sustained relief or the fire is put in check. If you encounter fire or dark, turbulent smoke at the entryway, this is where the attack will have to start. If you make a single hit from the original point of attack and it appears the conditions are holding, shut the bail and reposition the handline, if need be. Understand that achieving knockdown requires base water application. When the stream is not reaching the seat of the fire, it is only temporarily knocking back the burning gases, and conditions can rebound immediately after you shut down the nozzle. If this occurs, reopen the nozzle immediately and keep it open for the duration of the advance.

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

- A room offset from the approach corridor that is postflashover and extending out, where the stream is initially not reaching the seat of the fire.
- A wind-impacted condition is present, where the handline is advancing from the downwind side of the fire.
- A belowgrade fire, where the handline is advancing down the interior stairs.
- An advanced fire that is venting out or rapidly toward the point of entry.

Because these are not the typical "bread-and-butter" 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 your making the push and the fire pushing you out (photo 4).

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 that can be 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. This problem 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 saturate. This can produce an anecdotal confirmation bias each time a fire is extinguished without flowing and moving where the method was actually warranted.

Just because "the fire went out and nobody got hurt" 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 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. Maximizing the preservation of life and property must remain the core metric of our decision making.

Another issue derived from live fire training is the common practice of

(4) The outside vent firefighter ducks out of the way of the stream after taking the windows opposite the nozzle team's advance. *(Photo by Lloyd Mitchell.)*

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, at times, may 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 applied properly, the rate that 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 heat. Unlike the thick concrete and steel walls and ceilings of a burn building, which eventually become saturated with heat and begin projecting it back out (known as "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 the negative encounters firefighters may have had in the past, where fog streams were used in the 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 to encounter and the impact their tactics will have on the fireground.

Engine company firefighters must be well-versed in flowing and moving in various settings; the approach will not always be a straightforward, unobstructed hallway. They must be capable of advancing forward and backward and up and down stairs (including straight run, return, and circular types), navigating 90° and 180° turns and 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 down the handline). 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 the communication, coordination, and proficiency to operate effectively and efficiently (photo 5).

(5) Turbulent black smoke and vent-point ignition from the windows indicate advanced and rapidly deteriorating fire conditions. *(Photo courtesy of the NBFD.)* **(6)** Only steam can be seen exhausting from the vented window after the nozzle team pushed in and extinguished the fire. *(Photo by Lloyd Mitchell.)*

Sadly, flowing and moving are not emphasized or even included in many fire academies. Because people tend to reject or avoid that with which they are not familiar or comfortable, this can also be another source of contention regarding the method's use. Once firefighters are competent in the proper body mechanics to distribute weight, maximize leverage, and displace (reaction)

force in addition to proactive hose management, 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 enable an engine company to wield the full suppressive power of the handline—overwhelming and outmaneuvering the fire with the superior force of the stream and the advantageous tempo of the nozzle team (photo 6).

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.

The flowing and moving method is a matter of life safety for both firefighters and civilians. Not only can it restore/preserve the means of egress and the survivable space, but it is also essential if the nozzle team starts to get overrun 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 and extinguishing the seat of the fire. ■

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NICHOLAS PAPA is a lieutenant with the New Britain (CT) Fire Department (NBFD), where he has served for more than 14 years, and is assigned to Engine Company 1. A second-generation firefighter, he entered the fire service in 2003, volunteering for a neighboring suburb until his appointment to the NBFD. Papa is the author of the recently released book *Coordinating Ventilation: Supporting Extinguishment & Survivability* and has been an FDIC classroom instructor since 2017. He is a technical panelist for the UL-FSRI Study on Coordinated Fire Attack in Acquired Structures. He is also the founder of the fire training organization Fireside Training.

Nicholas Papa will present "Coordinating Ventilation: Supporting Extinguishment and Survivability" at FDIC International in Indianapolis, Indiana, on Wednesday, April 27, 2022, 1:30 p.m.–3:15 p.m.