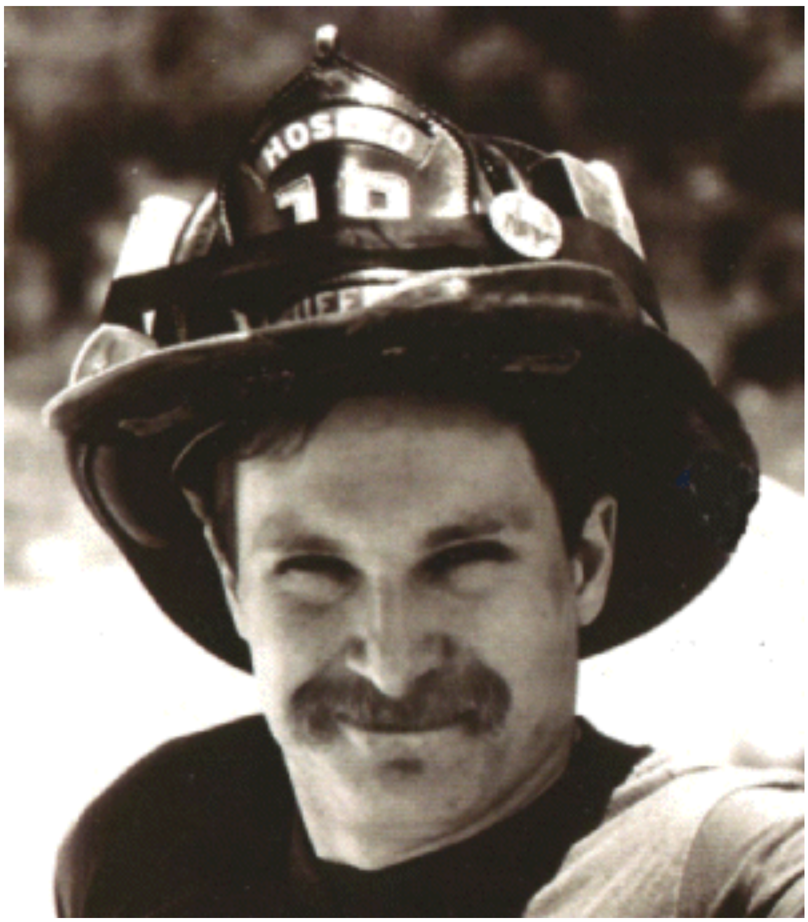
A TRIBUTE TO THE WORK OF ANDY FREDERICKS

(COMPILED BY: GARY LANE)



"FIGHTING FIRE WITH WATER"

Fire Nuggets Bio
Andy Fredericks

The late ANDREW FREDERICKS was a firefighter in the City of New York (NY) Fire Department (FDNY) assigned to Squad Company 18 in Manhattan, one of five squad companies high inside the First World Trade Center tower rescuing people when it collapsed on September 11, 2001. A member of the fire service for 21 years, Mr. Fredericks was a New York State certified fire instructor (Level II) at the Rockland County Fire Training Center in Pomona, NY, an adjunct instructor at the New York State Academy of Fire Science, a field instructor for the Illinois Fire Service Institute, an instructor for the New York State Association of Fire Chief's, and an adjunct lecturer at John Jay College of Criminal Justice in New York City. Mr. Fredericks was co-author of FDNY's engine company operations manual. He was a member of the Editorial Advisory Board of Fire Engineering and the FDIC Educational Advisory Board. He was president of Andrew A. Fredericks & Associates, Inc., a firm specializing in municipal fire service training and consulting. Mr. Fredericks held a bachelor of arts in political science, a bachelor of science in public safety/fire science, and a master's degree in fire protection management.

May We Never Forget You

Fire Nuggets

ANDY'S AMBASSADOR'S

BY DAVE McGRAIL

For the past several months, I have been thinking and searching for a meaningful topic to submit to my brothers at Fire Nuggets. Ted Corporandy and Paul Schuller have been very patient with me, but have remained tenacious with their requests of me, as I continue to procrastinate and miss deadline after deadline for submission. I always say that I will get an article ready for the next issue, but then I seem to get involved with another house project, fire department project, or whatever happens to be the current demand in my life. Then it just puts me that many more months in debt to my brothers at Fire Nuggets. So here goes, finally.

As I reach the completion of my first year as a district chief on the Denver Fire Department, my mind is continually swimming with thoughts and “firenuggets” which I would like to share. However, I place most of these on the back burner, in an effort to first share those items that always seem to rise to the top of my list.

Like many of my brothers out there, I am still, frequently thinking of the events of September 11, 2001. Specifically, I think of my friend and brother Andy Fredericks and the positive impact he had on my career and my life as both a friend and fire service brother. Many of our brothers have written articles in regard to nozzles and made dedications to Andy regardless of the subject. My intention here is not to repeat what you have already heard or read, but to build on what other brothers have said, specifically the recent Fire Nuggets article by my brother and friend Captain Tim Adams, Sacramento City Fire Department, Engine Co. 6.

Consider this a story about my friendship with Andy and our continued work to carry on Andy’s work by teaching and spreading a most critical message to our brothers throughout the American fire service.

Like several generations of firefighters over the past twenty to thirty years, I was initially raised and taught to fight fires with combination fog nozzles. In fact, as a brand new firefighter in a 1982, I had no idea there was any other type of nozzle out there other than the combination fog. I was taught to use a wide 60-degree fog pattern for fire attack, with a very strong emphasis on preventing any and all water damage. I was also taught to use the fog stream as a water curtain to protect exposures, and furthermore, I was taught to use a fog pattern to protect myself from the fire in front of me.

I remember my first experience with the propane Christmas Tree. What a fantastic and exhilarating training experience that was for a young firefighter, especially during a night-training drill. Twenty years later, I am still anxiously waiting to be dispatched to a Propane Christmas Tree on fire.

In the mid-Eighties, after taking several major beatings at various different structure fires, I was finally taught a very valuable, but hard, lesson. While using water fog (the way I was taught), I sustained serious steam burns to my ears and neck. I wasn't injured seriously enough to warrant a hospital stay, rehabilitation, or skin graphs, Thank God, but nevertheless, it was a painful and embarrassing experience. It was also the beginning of my quality education regarding fire streams, fire attack, and overall fire ground operations.

My most important mentor throughout my life, both personally and professionally has always been my father. Pat McGrail is a retired division chief of the Denver Fire Department, who worked 42 years before he retired. He never missed a shift in that entire 42 years. He never called in sick and always worked on the busiest fire companies in the city.

While trying for several years to get hired by the Denver Fire Department, I was fortunate enough to get hired on a smaller suburban fire department in the Denver metropolitan area. My father allowed me to find my own way and make mistakes along the way in order to gain my own experience. However, he was always available to answer questions and give advice.

With a bright red neck, blistered and swollen ears, I felt and probably looked a little like "Spock" from StarTrek. It was certainly impossible to hide the mistake of my inexperience from anyone, especially my father. His questions were not to belittle or poke fun at me, but rather designed to help me gain knowledge. "What size line were you using?" he asked. Followed up by "what type nozzle was at the end of that line?" These simple questions were the keys to solving what I would later learn to be a significant problem throughout the American fire service, but also a problem with a very common sense and simple solution.

It's been many years ago, but it seems like yesterday that I learned how dangerous it was to trust a 1½-inch attack handline, with a 95 gpm 100 psi combination fog nozzle between me and a much more formidable opponent. It was after that experience that I decided to dedicate my career to the study of fire streams, nozzles, handlines, and the various other critical components of the engine company.

Little did I know that at the same time a young firefighter by the name of Andy Fredericks was making his way into our great profession. Andy's dream was to become a New York City fireman. Like me, Andy had to work for many years to achieve his dream, working in both the volunteer sector as well as a medium-sized fire department in Virginia before his appointment to the FDNY.

Over the years, I gained as much knowledge as possible from my mentors, classes, seminars, books, videos, and my own personal firefighting experiences. I was also a dedicated reader of the periodicals, including Fire Engineering magazine. After working at a serious high-rise fire in 1991, I submitted what would become my first article to Fire

Engineering. Thanks to Bill Manning, I was able to get into the loop, which would lead to many great opportunities including my association with Andy Fredericks.

I felt that my knowledge and experience base in regard to engine company operations, handlines, and nozzles was strong; but there was always room for improvement. In 1995, I was quickly thumbing through the latest edition of Fire Engineering when I came across an article entitled “Return of the Solid Stream.” Needless to say, I stopped at that page, sat down, and for the next half-hour I read all of the information that I wished I could put down on paper and express to others. This guy, Andy Fredericks, was saying everything I believed but could never quite express in such an awesome and professional manner. I thought, "Who is this guy and where is he from?"

Andrew A. Fredericks, from FDNY Engine Co. 48, the bio read. With some additional research, I quickly found out that FDNY Engine Co. 48 was a very busy Bronx engine company that worked many serious fires on a regular basis. Fredericks was obviously a man with a strong formal education who could eloquently express his message and had the down-and-dirty firefighting background gained in the hallways of many a Bronx tenement to backup every word.

I was so moved by the article that I immediately got on the phone in an effort to express my thanks to Andy Fredericks and hopefully learn more from him. I reached Bill Manning and got a phone number. I called and got Andy’s wife at home, and she was kind enough to give me the telephone number to Engine Co. 48. We talked for quite some time. It was a great conversation, and, at the end, I knew that I had a new friend and ally in the effort to move the American fire service and my own fire department forward with regard to fire streams and fire attack. At that time, I had no idea how powerful Andy Fredericks’s message would become and how many men he would eventually reach.

Our friendship grew over time, and we would both call one another on a regular basis to share information, ask questions, or simply say hello. Andy continued to produce additional articles with an emphasis on the engine company message. Before long, his name would be recognized by anyone dedicated to our profession and their own personal professional development.

I really wanted to meet Andy in person, so my father and I made our way out to the “Big Apple” to attend an FDNY seminar on high-rise operations. While in New York, we made contact with Andy and caught a ride up to the Bronx to Engine Co 48’s firehouse on Webster Avenue. The standard FDNY hospitality took over, and we were treated like kings. The men at Engine 48 and Ladder 56 invited us to stay for dinner, and basically gave us the key to the Bronx. We talked with Andy and the brothers at the kitchen table for hours. It was an awesome experience. Andy’s boss that night was Lieutenant Billy McGinn. Another great fireman, who I would become friends with and look forward to seeing each year in Indianapolis at the Fire Department Instructors Conference (FDIC). Billy attended my presentation at FDIC that first year. I was extremely flattered that a lieutenant from one of the busiest fire companies in the world would honor me with his presence in my class. Billy is just one of many great men I have come to know through my association with Andy. Andy and Billy would die together as part of the brave Squad 18 team on that terrible day in September, 2001. I am so very proud to have known such great men.

During our visit to New York, Andy invited us to his home in upstate New York for dinner. After getting lost, and going over the Tapanzee Bridge about four times, paying the toll each time, we finally made it to Andy's house. Hey, two guys, two firemen, are definitely not going to stop and ask for directions. Andy and his wife provided great hospitality. They fed us a great meal, and once again we talked shop for hours.

After our visit to New York City, things really started to take off for me. Andy invited me to be a part of his engine company Hands On Training (H.O.T.) Team at the FDIC. You can't even begin to imagine how much of an honor this was for me. It was the beginning of one of the greatest adventures of my life. Andy thought enough of me to give me the honor to join his team as we spread the engine company message. The list of great men I have become friends with through Andy is too long to list in this article. But believe me, they are the "Dream Team" firemen from their respective fire departments. And what Andy started continues to grow today through each of them.

We are now "Andy's Ambassadors." These great men are all across the American fire service, from coast to coast. And you can become one too! It starts when you make the decision to dedicate yourself and your life to our great profession, and specifically the engine company operation. Proper nozzle and hose-line selection, with a good stretch and advancement of that weapon. You put it all together with an appropriate fire attack by locating, confining, and extinguishing the uncontrolled nature.

I was recently given the honor of speaking at the Boise Fire Department's Seventh Annual Fire Safety Symposium. My new friend and brother Tracy Raynor, division chief of training, Boise F.D. invited me to this year's symposium. It was an absolutely fantastic experience. Brother Raynor is one of Andy's Ambassadors too.

During the symposium, I spoke about Andy and his hard work toward educating us in the American fire service. I told the brothers in that audience that if they really wanted to honor Andy's memory, they could begin by removing their automatic combination fog nozzles from their high-rise standpipe hose packs.

The tragic One Meridian Plaza Fire occurred over ten years ago in the City of Philadelphia. Three brother firefighters died in that fire. Even after that tragedy, a NIOSH Alert Bulletin, NFPA #14, and all of the information available to us throughout the American fire service, including all of Andy's hard work, and the deadly combination of 1¾-inch hose and automatic combination fog nozzles still exists on many, if not most, high-rise standpipe hose packs of fire departments all across the country. What a terrible shame! We can't bring Andy back, but we can honor him by learning from him and our own past experiences.

If you want to become one of Andy's Ambassadors, begin with some research. Start with "Return of the Solid Steam" and read all of Andy's articles he wrote for and were published by Fire Engineering magazine. The FE web site will guide you by the author's name in your search for these articles, what year, which month, etc. Also, Andy worked for hours to produce several videos regarding Stretching and Advancing Handlines, as well as his video on Fire Attack. All are Fire Engineering/Pennwell Videos. And NO, I am not the marketing director for FE or PW, but I am one of Andy's Ambassadors, and you must hear his message! If you're reading this as a Fire Nuggets member, then you can quickly go to the archives and read several articles Andy produced for Fire Nuggets.

If you never had the opportunity to listen to Andy or see him in person, I am truly sorry. He was a fantastic speaker. The rooms at the FDIC were standing-room-only with men spilling out into the main hallway. I truly regret not getting Andy out to Denver to speak before we lost him. Whatever it is, don't put it off, do it today, "carpe diem."

After the FDIC-West in Sacramento, Spring of 2001, Andy and I were invited by Brother Tom Murray, (retired San Francisco captain, and one of Andy's Ambassadors) to speak at a S.F.F.D. Training Program. Once again, a great honor. Especially great for me because I had the opportunity to share the stage with Andy Fredericks, just a few months before we would lose him.

Andy had rented a car in Sacramento, and we drove from Sacramento to San Francisco together. We talked about everything during that drive, including nozzles. Tom Murray treated Andy and me, along with several other great brothers to dinner at Izzies Steak House in the Marina District. We spent the night at Tom's Command, Engine 39. It was a great time, and I will always remember my time spent with Andy.

In late June of 2001, the weekend before the Fourth of July, I was in New York for the FDIC Educational Advisory Board meeting. Andy and I were both members of this Advisory Board. After the meeting, my father flew out to Newark. I picked him up, and we buffed in New York City all weekend. We put 500 miles on the rental car in two days and nights, saw some fires, and caught up with many good friends and brothers. Our last stop was Squad 18 in Lower Manhattan on our way to Newark Airport late Monday afternoon. We visited with Andy; he busted my chops; and I busted his. As we pulled away from Squad 18's quarters, my father yelled out, "Hey Andy," and took Andy's picture as he waved goodbye to us. That would be the last time we would see Andy.

Back at home in Denver we went through the developed photos, and I quickly went past the photo of Andy in front of the firehouse, not giving it a second thought. After September 11, that photo means more to me than I would have ever imagined.

I was in the shower at home on September 11. It was my day off, and it was also my wife Gina and my wedding anniversary, so I was attempting to get my act together and figure out a gift. She called me and told me to turn on the TV. My reaction was the same as yours, disbelief. I didn't think the buildings would collapse, but I felt that even the experience and resources of the FDNY wouldn't be able to stop the fire.

After the collapse, I called New York, Andy's home. I briefly spoke with Andy's wife Michelle. I realized she would probably be getting many phone calls, but I needed to check on Andy. I asked Michelle if Andy was safe; she said he was at work and she thought he went on the 2nd Alarm. My heart sank, I knew he was probably gone. And he was.

It is not the one event of a day in history that defined who Andy Fredericks was. It was, in fact, his entire life, dedication to his family, and to our profession that made the man. He was a great firefighter, not only by his heroic actions that terrible day, but also by the contributions he made in his twenty-plus years in the American fire service. You can carry on his message as one of Andy's Ambassadors. Are you up to it?

I will address the specifics on what I like to call “Proper Weapons Selection” in the next issue of Fire Nuggets. Here's a very brief preview:

Andy proved to the fire service that we really need to be delivering water in a straight-stream pattern or from a smooth bore/solid stream nozzle for interior structural firefighting. Most fire departments and fire training schools teach straight stream water application.

If you want to make it easier on the firefighters, and lower the nozzle reaction, you can cut water volume, or nozzle pressure. The smooth bore/solid stream cuts out nozzle pressure, and keeps the volume. Lower nozzle reaction, less work, more water!

Last, the water is now being delivered in the form it should be in to begin with, thus minimizing steam production and maximizing visibility.

And, NO, Andy's Ambassadors are not anti-fog-nozzle. We simply want our brothers to survive by choosing the proper weapon for the specific operation. More specifics next time.

I am thankful to have been given the opportunity to know Andy Fredericks. He will always be my friend and brother. I am also eternally grateful to Andy for the countless great men I now am associated with because Andy brought us all together. They are “Andy's Ambassadors.”

May God bless Andy and his family.

Battalion Chief Dave McGrail, Denver Fire Department

*"If you put the fire out right in the first place,
you won’t have to jump out the window."*

Fire Engineering
September 1995

RETURN OF THE SOLID STREAM

BY ANDREW A. FREDERICKS

A growing number of fire departments large and small are returning to the use of solid-stream nozzles (also called "smooth-bore" or "solid-bore" nozzles) for interior structure firefighting. They are realizing success in directly attacking interior fires using the long reach afforded by the compact solid stream and fire-quenching power of its high-volume flow. This article is intended to describe some of the many benefits provided by solid streams and to contrast the safety and efficiency of the direct method of fire attack with both the indirect method and the so-called "combination" attack. When I first entered the fire service in the late 1970s, many of my instructors taught both the indirect and combination methods of fire attack with little or no mention of the direct method. Training films of the period demonstrated the supposed efficiency of using 30- and 60-degree fog patterns for interior fire attack, and live fire drills often involved tolerating extremely debilitating heat conditions brought about by inappropriate use of fog streams. As recently as 1987, while engaged in a training exercise as a member of a career fire department in Virginia, I received a second-degree steam burn on my face due to improper use of fog within the training building--even while wearing a protective hood.

Although my instructors preached the gospel of fog, the most experienced nozzlemen I fought fires with consistently used straight streams and the direct method of extinguishment. I, too, adopted this method of aggressive, interior fire attack; and, in my 16 years as a career and volunteer firefighter, I have never used anything but a straight stream or solid stream inside the fire building.

Whereas the indirect method of attack, if employed properly at fires involving unoccupied enclosed spaces such as attics and cocklofts, can be a valuable tactical tool, the same cannot be said about the combination method. In my opinion and that of a growing number of firefighters and fire officers, the combination attack should be permanently retired to the scrap heap of tried and failed firefighting techniques. In almost all cases, an aggressive, interior, direct attack will provide for rapid and efficient fire control while minimizing the potential of burn injury to civilians and firefighters.

PRINCIPLES OF DIRECT EXTINGUISHMENT

The direct method of attack involves applying water directly on the burning fuel to cool it below its ignition temperature and suppress production of volatile vapors. If the fire is small and localized, a fire stream, such as that from a pressurized water extinguisher, may be aimed directly at the base of the flames; in short order, the fire will be extinguished. Even in the case of a mattress burning in a bedroom or rubbish burning in a hallway, a stream from a handline can be applied directly on the burning materials. In the case of larger fires--those approaching flashover and those already in the fully developed phase--it may not be possible or safe to immediately apply a stream of water directly on the burning fuel. Due to burning fire gases rolling across the ceiling, high heat conditions, and/or partitions and obstructions interfering with the direct application of water, the stream first must be deflected off the ceiling and upper walls until the nozzle team can get close enough to permit direct cooling of the fuel.

Some members of the fire service confuse the deflection of a straight stream or solid stream off the ceiling and walls with "indirect" extinguishment. The purpose of directing the stream upward at a 60- or 70-degree angle is not to cause rapid cooling of the effluent fire gases (which will create large amounts of steam, as in the indirect and combination methods of attack) but to allow droplets of water from the stream to rebound off the ceiling and walls, penetrate thermal currents produced by the fire, and start cooling the burning fuel--all while the nozzle team operates from a safe distance. Once the rolling flame front at the ceiling has been repulsed due to a reduction in fire gas development, the nozzle team can make a close approach to the seat of the fire and complete the extinguishment process.

CRITICAL FACTORS

Four critical factors affect the safe and efficient extinguishment of fires using the direct method:

-Volume or flow sufficient to overcome the heat being produced by the fire. Many fire attack operations have been doomed to failure simply because the size of hose was too small to deliver the proper flow or the nozzle was designed with a flow range too limited for the job at hand.

-Form or shape of the water as it leaves the nozzle (commonly called the "pattern") and as it reaches the burning fuel. The goal is to get water on the fuel-flame interface without premature vaporization of the water and excess steam production.

-Reach and penetration of the stream, enabling the nozzle crew to initiate operations from a safe distance and allowing "the water to do the work." I am not saying to open the nozzle on smoke, but the nozzle team does not have to be so close as to risk severe burn injury. In addition, the hydraulic force of the stream should be sufficient to allow penetration of tightly packed or baled materials.

-Ventilation. This critical factor must be timely and adequate. Ventilation is essential to remove combustion gases, smoke, and unwanted steam and permit an unhindered advance to the seat of the fire. We learned in basic firefighter training that when water converts from liquid to vapor at 212°F, it expands some 1,700 times its volume. Most of us were never taught, however, that at 1,000°F, a ceiling temperature easily attained at interior fires, water expands some 4,000 times! Without a large channel or opening through which to remove this superheated steam safely to the outside, suppression crews will be enveloped in the expanding steam and subjected to extreme discomfort and often painful burns.

Regardless of the type of stream--fog, straight, or solid--whenever a nozzle is opened in the fire building, conditions for the nozzle team immediately worsen. Most visibility is lost, and it can become uncomfortably hot and humid even near the floor. There is no magic fire stream, but a direct attack with straight or solid streams coupled with proper ventilation wins hands down over the combination method in maintaining more tolerable interior conditions.

SOLID STREAMS VS. STRAIGHT STREAMS

Although their use in direct attack is similar, straight and solid streams have distinct differences. A straight stream is, in essence, a very narrow fog stream. It is produced by a combination nozzle and is composed of millions of tiny water droplets separated by air entrained within the stream. One text identifies the narrow stream produced by a fog nozzle as a "solid" stream, but this is not correct. A solid stream is produced by a smooth-bore orifice and is a compact, solid cylinder of water as it leaves the nozzle. With proper tip pressure, a solid stream will remain compact for a considerable distance before friction with the air, gravity, and other factors degrade the quality of the stream.

One important reason solid streams are more effective than straight streams in interior fire attack concerns water droplets. When a solid stream is deflected off the ceiling and walls, it produces droplets of sufficient size and mass to reach the burning fuel without being carried away by thermal currents or vaporized prematurely by the heat of the fire. Straight streams--created by fog nozzles and therefore the result of changing the direction of water travel within the nozzle by striking the stream against a deflector (most fire service nozzles are of this type, called periphery jet)--consist of countless small droplets that are made even smaller in colliding with the ceiling and upper walls. These smaller droplets, with their low mass, are drawn into and propelled out of the thermal column of the fire, never reaching the burning fuel--producing excess steam and wasting water.

MISCONCEPTIONS ABOUT SOLID STREAMS

Misconceptions about solid streams abound within the fire service community. I will address some of the most common ones. The first and most commonly held misconception is that a solid stream, unlike a fog stream, does not offer the nozzle team protection when operating inside the fire building. I`m sure you`ve heard that the fog pattern will protect you should fire roll over your head or flashover occur or a gas pipe suddenly fail and create a jet of burning natural gas. It is simply not true! Using fog inside the fire building does not protect you; it burns you. The combination attack has been largely discredited because of its injury-causing potential, inefficiency, and the lack of evidence to prove otherwise.

I`ve encountered fire rolling over my head and failed gas piping, and the solid stream always offered ample protection. This misconception has it beginnings in "war stories" told to probies by "senior men" who remember the days when fog--especially high-pressure fog--was all the rage. In those days, the few self-contained breathing masks available were so bulky, heavy, and time-consuming to don that crews on the first attack line often opted not to use them. The "johnies" were amazed by stories of nozzlemen who had to "breath the air from the fog pattern" just to stay in the fire building--leaving yet another false impression that fog is a lifesaver. In reality, it is the volume and reach of the stream (in conjunction with your protective clothing and SCBA, of course) that protect you--nothing else.

The next most common misconception concerns water damage. You`ve heard it, and I`ve heard it: Solid streams cause more water damage than fog streams. Again, it is not true. William Clark in Firefighting Principles and Practices describes several tests conducted to determine the amount of water runoff from fires extinguished by solid streams and fog streams. In trial after trial, runoff from the fires extinguished by solid streams was consistently less than that from fires extinguished by fog streams at the same flow. I believe the reason is that a solid stream, used in a direct attack on the burning fuel, will knock down the fire much more quickly than a fog stream. If the nozzleman shuts down almost immediately after darkening down the main body of fire, water damage will be minimized and overall fire attack effectiveness and safety will be enhanced. These test results aside, firefighter safety and prompt control of a serious fire are absolutely more important than any concerns about water damage. If they are not, you should carefully reevaluate your tactical priorities.

A related misconception concerns water conservation. For years, many rural fire departments--and even some suburban ones--believed that, by using low-flow fog nozzles at structural fires, the water supplies carried on board their apparatus could be extended until the fire was extinguished. Problematically, unless the gpm flow being discharged was sufficient to overcome the heat produced by the fire, it continued to grow. Eventually the on-board water supplies were exhausted and by the time drafting operations, tanker shuttles, or relay operations were established, all that remained of the fire building was smoldering rubble. The key, as reflected in most modern rural fire attack operations, is to hit the fire hard and fast with ample volume to quickly knock down the fire and limit extension.

Another misconception concerns nozzle reaction. I`ve heard line officers at training sessions state that solid streams produce more nozzle reaction than straight streams. False! Solid-stream nozzles require lower operating pressures than standard fog nozzles, producing significantly less nozzle reaction and making hoselines less stiff and easier to move around corners and newel posts. In general, at equal flows, a 100-psi combination nozzle in straight-stream position will generate one-third more nozzle reaction force than a solid-stream nozzle operated at 50 psi. In an effort to control the straight stream and its higher reaction force, the nozzleman may change to a fog pattern (lessening nozzle reaction but also reducing reach) or the shutoff may be partially closed, breaking up the stream and/or reducing the flow. Any of these actions will compromise the safety of the nozzle team, and firefighting efficiency will be lost.

Misconceptions also exist about why lower pump discharge pressures resulting from the use of solid streams are better and safer than higher pressures needed to supply straight streams. Several recent articles decry those who call for lower operating pressures. One such article (purported to separate fire stream "facts" from "fantasies") points out that today`s fire hose is designed to resist pressures of at least 300 psi and that our modern pumping apparatus is designed to pump higher volume and higher pressure. This article states that since our equipment can handle the higher pressures, reducing the workload on our personnel is the key issue.

But, if this is such an important concern, why should fire departments employ fog nozzles that produce more nozzle reaction (in straight-stream position) than solid-stream tips at the same flow and make the hoseline steel hard and extremely difficult to bend and advance? In addition, higher pump pressure is a serious safety issue. Although present-day pumping apparatus is designed to operate efficiently over a wide range of discharge pressures, higher pressures are dangerous. In the real world, hose lengths burst and injure firefighters (pump operators most often) and damage apparatus and equipment. This danger is especially great when pressures greater than 250 psi are needed to supply standpipe systems in conjunction with the use of combination nozzles.

Another misconception is that solid streams degrade rapidly after leaving the nozzle whereas straight streams hold together better due to the design of the combination nozzle, which produces a more uniform "exit" velocity across the stream. In most cases, the reason some solid streams appear to break apart so rapidly is that they are over-pressurized. Most texts state that a solid-stream tip should be operated at 50 psi. In reality, lower tip pressures are better, and engine company chauffeurs in the City of New York (NY) Fire Department (FDNY) commonly supply 40 psi to the tip, producing a better, more compact fire stream. "Old timers" in the FDNY state that even lower tip pressures may be advantageous--especially when using 2 1/2-inch hose. Supplying only 30 to 35 psi to a 1 1/8-inch tip attached to 2 1/2-inch hose produces a fire stream with considerable reach, adequate volume (about 210 to 230 gpm), and reduced nozzle reaction.

STANDPIPE FIREFIGHTING OPERATIONS

One of the areas in which fire departments continually demonstrate tactical deficiency is standpipe firefighting operations. NFPA 14, Standard for the Installation of Standpipe and Hose Systems (1993 edition) states that Class I and III standpipe systems need only supply 100 psi at the most remote floor outlet. The 100 psi represents required tip pressure when using combination nozzles, but what about friction loss, which is at least 20 to 25 psi per 50-foot length of 1 3/4-inch hose at approximately 200 gpm? Older standpipe systems may only supply 65 psi at the most remote floor outlet, and a pressure this low can be safely used only in conjunction with three lengths (150 feet) of 2 1/2-inch hose and a 1 1/8-inch solid-stream tip. Critics will say that pressures can be increased sufficiently to properly supply combination nozzles once fire department pumpers begin augmenting the system. This is true in some cases; but as the Philadelphia Fire Department found out at the One Meridian Plaza high-rise fire in 1991, permanently affixed pressure-reducing hose outlet valves installed on standpipe outlets in very tall buildings will defeat any attempt to effectively augment pressures. Standpipes may also suffer from inadequate maintenance, vandalism, and clogging of the system`s piping by debris--all of which reduce outlet pressures and prevent effective augmentation. Even when higher pressures can be supplied to the floor outlets, there is a danger the system riser and/or fittings may fail due to improper design or the use of pump pressures that exceed the system`s rated pressure.

Another lesson learned from the One Meridian Plaza fire is that some types of automatic fog nozzles require a minimum pressure of 40 to 50 psi at the tip to actuate the pressure-control mechanism and produce a stream. Other departments have reported similar problems, some narrowly averting tragedy when nozzle teams were unable to flow water or suddenly lost pressure and could only dribble a stream in the direction of the fire as they beat a hasty retreat. Appendix A of NFPA 14 states the following in regard to this potentially dangerous situation: "Constant pressure (automatic) type spray nozzles (See NFPA 1964) should not be used for standpipe operations because many of this type require a minimum of 100 psi at the nozzle inlet to produce a reasonably effective fire stream." The potential to flow 200 to 250 gpm at extremely low pressures is the single most important reason solid-stream tips must be used during standpipe firefighting.

I believe it is necessary to discuss a related issue concerning standpipe operations--hoseline diameter. The FDNY uses 2 1/2-inch hose for all standpipe operations, and with good reason. The heat output of fires in high-rise office buildings requires a large volume flow to achieve successful extinguishment. Fires in high-rise residential buildings of concrete construction also demand the use of the "big line" to help overcome the oven-like conditions usually encountered. Multiple 1 3/4 or two-inch lines simply cannot provide the volume of flow that one or two properly placed 2 1/2-inch lines can. Sadly, as long as fires in high-rise buildings continue to be fought with nozzles of inappropriate design and handlines of insufficient diameter, more tragedies await America`s fire departments.

THE PROOF IS IN THE PERFORMANCE

Many fire departments have returned to the use of solid streams and many others are considering doing so. Not just large departments, but many small ones, have discovered the numerous benefits in using solid-stream nozzles for interior fire attack. I have helped train several fire departments in the proper use of these nozzles, and the response of firefighters and fire officers has been overwhelmingly positive. As a matter of fact, one fire chief told me that, since he placed solid-stream nozzles in service alongside his department`s automatic fog nozzles, the fog nozzles have been virtually forgotten. The bottom line is this: Fog nozzles are suitable for use in direct fire attack, provided they are used in straight-stream position and proper tip pressures are supplied by the pump operator. (This last point is especially important to ensure an adequate flow with automatic fog nozzles.) Solid streams are designed for efficient direct fire attack with less nozzle reaction and fewer operating variables, making them the better, safer choice in almost all situations. Maybe your department should consider a return to the solid stream.

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METHODS OF FIRE ATTACK

BY ANDREW A. FREDERICKS

Direct method: Involves direct water application on the burning fuel to cool it below its ignition temperature and eliminate production of vapors that burn.

Indirect method: Developed during World War II as a means of combating fuel oil fires in the confined machinery spaces of large ships and later applied to structure firefighting. Lloyd Layman, the primary proponent of what he called the "indirect" method of structure fire attack, explained the theory and methodology in his book *Attacking and Extinguishing Interior Fires*. In it, he identified the key requirements for a successful indirect attack, paraphrased as follows:
-Fog streams should be remotely injected into the fire area at the highest possible level from positions outside the involved building due to the danger of steam burns to nozzle crews.
-The fire should be sufficiently well-developed, as fires in the first phase or early second phase are effectively suppressed using direct methods.
-Doors and windows in the fire building should be intact (shut), and ventilation must be delayed until after the injection of water fog has ceased.
Indirect attack methods, while potentially effective, have a limited range of application on the fireground and must be carefully employed to achieve satisfactory results.

Combination method: Developed as a result of misunderstanding and confusion concerning Layman`s writings, as well as advances in personal protective equipment and self-contained breathing apparatus that permitted suppression crews to penetrate deeper into fire buildings. The combination attack requires the nozzle team to perform an interior fire attack using at least a 30-degree fog pattern directed at an upward angle and rotated rapidly in a clockwise motion to absorb a maximum amount of heat from the fire environment. As the seat of the fire is reached, clockwise sweeps with the nozzle should also provide some direct cooling of the fuel. The pattern also can be adjusted at this point to a straight stream to provide sufficient penetration for final extinguishment. The combination method is characterized by excessive steam production; zero visibility due to disruption of the thermal balance; and the danger of pushing flammable fire gases, smoke, and flame into uninvolved areas of the building due to the high-pressure zone that exists ahead of all fog patterns. Without appropriate ventilation, the danger of forcing heat and flames up and over the heads of the nozzle team is another real danger.

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STANDPIPE SYSTEM OPERATIONS: ENGINE COMPANY BASICS

BY ANDREW A. FREDERICKS

When fires occur in buildings equipped with standpipe systems, engine companies are responsible for completing three critical tasks:
1. supplying or augmenting the standpipe system to ensure an adequate volume of water at proper pressure;
2. transporting hose, nozzles, fittings, and other tools to the hose outlet valve selected for use; and
3. stretching and advancing a hoseline to control and extinguish the fire.
Before examining each of these tasks and some of the many difficulties encountered when operating with standpipe systems, let`s briefly review the various types of standpipe systems and where they might be found. (A bibliography is provided at the end of this article for reference and further study.)

TYPES OF STANDPIPE SYSTEMS

Standpipe systems are categorized according to the size (diameter) of the hose outlets and as being either "wet" or "dry." NFPA 14, Standard for the Installation of Standpipe and Hose Systems (1993 edition), establishes three classes of standpipe systems:
Class I--2 1/2-inch outlets for firefighter use,
Class II--1 1/2-inch outlets with 1 1/2-inch hose for occupant use, and
Class III--2 1/2-inch outlets and 1 1/2-inch outlets or 2 1/2-inch outlets reduced to 1 1/2-inch with a removable fitting for occupant and firefighter use. Usually 1 1/2-inch "occupant-use" hose is provided.

Some Class III systems may not contain any occupant-use hose (also called "house line"), especially in buildings protected by automatic sprinklers. In older industrial and manufacturing buildings (and some residential buildings), 2 1/2-inch occupant-use hose may be encountered. Engine companies should never attempt to use the unlined, linen hose provided with standpipe systems. It often is old and improperly maintained and may fail under fire department operating pressures. An exception to this rule applies to a ladder or rescue company operating remotely from an engine company while performing searches. Stretching and operating occupant-use hose would be justified in an attempt to save civilian and firefighter lives.

Wet standpipe systems contain water in the riser at all times. The water is supplied by municipal main, gravity tank, pressure tank, or a combination of these sources. In many cases, manual or automatic fire pumps are used in conjunction with municipal water supplies to boost pressures on the upper floors of tall buildings.

Standpipe systems may also be "dry." Some dry standpipes operate on the same principle as automatic dry sprinkler systems. Just as water is admitted to a dry sprinkler riser automatically when pressurized air is exhausted through an open sprinkler head, water enters the dry standpipe riser once the air is released through an open hose outlet valve. Other types of dry standpipes use a deluge-type of valve. Supply sources for automatic dry standpipe systems are the same as those for wet systems. Many dry systems, however, have no automatic source of supply and depend solely on fire department pumpers to provide the system demand. A combination system or combination sprinkler/standpipe consists of sprinkler heads and standpipe hose outlets attached to a common riser.

LOCATIONS OF STANDPIPE SYSTEMS

Requirements for installing standpipe systems are predicated on several factors, the primary of which are the height and area of the building or structure. Many building codes require that standpipes be installed in buildings that exceed three stories in height or pose special hazards associated with their large floor areas or occupancy type. In many older cities, especially in the Northeast and upper Midwest, it is not uncommon to find multiple dwellings up to seven stories in height without standpipe systems. In my area of the Bronx (New York), manual hose stretches of 10, 11, and 12 lengths (500 to 600 feet) sometimes are required for top-floor fires in these buildings. A recent Bronx fire required some 17 lengths (850 feet) of hose to reach the burning apartment.

Other factors also influence the need for standpipe systems. In locations that do not afford access to fire apparatus, such as parking garages, standpipes usually are required. Where excessive distance precludes laying supply hose or manually stretching handlines, such as on bridges or in tunnels, standpipe systems may be required as well. A list of locations often equipped with standpipe systems follows:
high-rise residential and office buildings;
large-area buildings such as hospitals, terminals, warehouses, manufacturing facilities, and industrial buildings;
enclosed shopping malls;
theaters, stadiums, and arenas;
above- and below-grade parking garages;
bridges and tunnels;
limited-access highways; and
piers and wharves.
Engine companies must conduct pre-incident planning activities to identify the locations of standpipe systems within their response areas and any associated problems or special characteristics.

The remainder of this article is directed at standpipe operations in high-rise residential and office buildings, since they can be found in almost any community and fires in these buildings present many complex challenges.

SUPPLYING STANDPIPE SYSTEMS

The first critical task facing engine companies arriving at a fire in a standpipe-equipped building is to establish a water supply by pumping into the siamese connections. Hose used to supply standpipe systems should be the largest available and at least three inches in diameter. Some jurisdictions require that building owners provide third-turn or quarter-turn couplings at siamese connections to accommodate four- and five-inch hose. In the case of wet standpipes, fire department pumpers must augment the system to ensure flow needs are met at adequate pressures. In the case of dry standpipe systems, fire department pumpers provide the only water supply available for firefighting.

It is important to provide an independent and a redundant water supply by using a separate pumper for each siamese connection. This ensures that firefighters advancing hoselines will have an uninterrupted supply of water should a pumper suffer a mechanical failure, the siamese connections supply only dedicated risers, or a zone-control valve be shut without firefighters` knowledge. Each engine company assigned on the first alarm should take a position at a nearby hydrant and stretch a supply line to the appropriate siamese connection. The larger the building, the more likely a multiple siamese connection will be present, often on different street fronts.

COMMON SIAMESE CONNECTION PROBLEMS

Should only a single siamese connection be available or the siamese connection be unusable due to vandalism, the standpipe system can be supplied through a first- or second-floor hose outlet. Supplying a standpipe system through a lower-floor outlet requires that the appropriate fittings and adapters be brought into the building and that any pressure-regulating devices installed at the hose outlet be removed or adjusted to the fully open position so as not to impede the water supply. Note that some pressure-regulating devices (PRDs) cannot be "back-fed" through the discharge side of the hose valve. A more complete discussion of pressure-regulating devices is included below.

Problems caused by vandalized and inadequately maintained siamese connections often will be encountered. Some of these problems may include missing caps, stuck caps, damaged threads, female swivels that do not spin freely, out-of-round female swivels, missing female swivels, garbage- and debris-clogged connections, and broken or jammed-open clapper valves.

Stuck caps and frozen female swivels. It may be possible to loosen trapped dirt and paint by tapping the cap or swivel with a spanner wrench. Large spanner wrenches or a 36-inch pipe wrench may also be needed to free a cap or swivel. If a swivel cannot be loosened, attach a double-male fitting followed by a double-female, thus improvising a swivel and allowing the supply hose to be attached. In areas of high vandalism, "break-away" vandal-proof caps may be installed. If they are plastic, it sometimes is possible to strike the cap in the middle, breaking it in two and permitting easy removal. Metal caps usually are best removed by prying one of the screw eyes off its pin lug with the prying end of a spanner wrench. Plastic caps also can be removed in this fashion.

Missing caps. They should not interfere with supply operations unless garbage has been placed in the siamese connection that must be removed or a clapper valve is jammed open, thus allowing water to flow out the uncapped side. Note: Be careful when removing garbage and debris stuffed inside siamese connections. Never stick your fingers or any part of your hand inside a siamese connection to clear it. Junkies have been known to store or discard hypodermic needles in them. If debris or garbage must be removed, a pipe, hydrant, or spanner wrench handle makes an excellent probe. It is a good idea for pump operators or engine company chauffeurs to carry a flashlight at all times for the purpose of peering into connections to see if debris is entrapped and the clapper valves are functioning. At night, a flashlight may be needed to find a siamese connection hidden behind shrubbery or fencing and to correctly differentiate between a standpipe and a sprinkler siamese.

A missing cap and a clapper jammed in the open position. These situations can be handled by attaching a spare male cap to the unused side of the siamese connection or immediately attaching a second supply hose. Missing female swivels or swivels out of round. They are another story. I responded to a fire in a public school in which all but one female swivel had been removed from the standpipe siamese connections along the front side of the building. The problem did not appear critical because the remaining swivel was operational. Unfortunately, the clapper valve inside this siamese connection was jammed open and could not be closed. This caused most of the supply water to flow out the other side of the connection, which could not be capped due to the missing female swivel. Although some water was available at the floor outlet, the pressure was extremely low and a hoseline had to be hand stretched from the third-due engine. While the problem of absent or severely damaged female swivels can be overcome in some cases by attaching the supply hose to a lower-floor outlet, anticipate delays in getting the standpipe system charged. Using lower-floor outlets for supply may require stretching three or more lengths of hose.

Malfunctioning one-way check valve between the siamese connection and the standpipe riser. This problem also requires that floor outlets be used for supply. Pump operators must constantly monitor their pumps for signs of churning (an indication that no water is flowing) and radio reports from the nozzle team or incident commander to ensure supply operations are successful.

LOGISTICS

Transporting the hose, nozzle, adapters, fittings, and other tools necessary to properly hook up to a floor outlet and place a hand-line in service is the second critical task required of engine companies. In inner-city areas, elevators in apartment buildings are unreliable and often out of service completely, necessitating that hose and other equipment be lugged up the stairs--sometimes more than 20 stories. Even in residential and commercial high-rises with well-maintained elevators, water entering elevator shafts due to operating sprinklers may render them inoperable, thereby forcing fire companies to make an arduous climb. Engine companies typically can use one of the following methods to transport their hose and equipment: Have each firefighter carry a folded length of 2 1/2-inch hose over his shoulder and bring a separate "standpipe kit" (usually a tool bag or an old mailbag) that he can carry or sling over the opposite shoulder. This method is used by the City of New York (NY) Fire Department. In some companies, the standpipe kit is assigned to a firefighter, but many engine company officers carry it because each firefighter is already saddled with some 100-plus pounds of gear and equipment. FDNY engine companies are staffed with an officer and four or five firefighters; this affords the luxury of bringing at least three lengths of hose into the building simply by requiring each firefighter to carry one. Except for the largest cities, most engine companies respond with a total of three personnel (officer, chauffeur, and firefighter), and carrying the hose in this fashion usually is not a viable option.

Carry the hose in a soft-sided bag or strapped together with nylon seat belts or webbing. The carry bags and straps may be homemade, but several different types are available from commercial vendors. Nozzles most often are preconnected and a set amount of hose--usually 100 feet--is carried in each bag or belted load. Hose loads arranged in this fashion may be slung over the shoulder or SCBA cylinder or may be carried by two firefighters using the handles provided. Additional tools and equipment usually are carried in a separate, smaller bag.

Use a hand truck. As much as 200 feet of hose--as well as fittings and adapters needed at the hose outlet--may be carried on a single hand truck. Hand trucks are efficient because even where engine companies are minimally staffed, two people can bring to the point of operation the hose needed for the first attack line. This saves valuable time over a piecemeal delivery system and allows the first handline to be placed in service much more quickly. One drawback to hand trucks is the difficulty in pulling them up several flights of stairs. It is important that the hand truck be as lightweight as possible (without sacrificing durability) and have pneumatic tires that roll more easily over stairs.

THE STANDPIPE KIT

What fittings, adapters, and other equipment are needed at the hose outlet to place a handline in service? The first piece of equipment required in any standpipe kit is a nozzle. Even if a nozzle already is attached to the hose, a spare nozzle may be needed if the first one breaks or becomes clogged with debris. All standpipe kits should also contain spare control wheels for the outlet valve (they often are missing) and a pipe wrench in case the valve stem is stripped and a control wheel cannot be attached. Channel-lock or vise-grip pliers often can be used instead of a pipe wrench. In FDNY, a 2 1/2-inch to 2 1/2-inch in-line pressure gauge is carried in the standpipe kit and is invaluable for setting accurate nozzle pressures (see sidebar "The In-Line Pressure Gauge" on page 41 for a more complete discussion on its proper use).

The standpipe kit also should include at least two spanner wrenches, door chocks, latch straps, and a wire brush for cleaning threads. Adapters may be required in case outlet threads are incompatible with local fire department threads. In many cases, outlet threads are pipe thread and not National Standard. In areas with rampant vandalism, a universal thread adapter might be a useful addition to the kit and can be employed when threads are badly damaged. If you find that threads sometimes are missing, carry a section of pipe with pipe thread on one end and National Standard (or local fire department) thread on the other. It can be quickly attached and can save valuable time over moving down a floor to hook up.

No matter how the hose and equipment are transported from the pumper to the hose outlet, any time elevators are used a set of forcible entry tools (flathead axe and halligan) must be brought along. Engine companies should not depend on ladder or rescue companies to always be nearby and available to help should they get stuck in an elevator. In addition, it may be necessary to force a door out of (or into) a stair enclosure or force a door or breach a wall to gain access to an area of refuge.

OPERATING FROM STANDPIPE SYSTEMS

The final critical (and often punishing) engine company task is to place a handline in service to control and extinguish the fire. Placing this handline in service, however, requires careful consideration of several important factors: the location of the fire within the building (what floor is it on? What area or occupancy is it in?), the distance between the fire and the nearest hose outlet, limitations on developing effective fire streams due to constraints of the standpipe system, the availability of adequate numbers of firefighters to place the first handline in service promptly, and sufficient relief personnel to ensure the first handline continues an unhindered advance on the fire despite depleted air cylinders or injuries to the nozzle team. The importance of the first handline cannot be overstated, and the incident commander must direct whatever resources are necessary to support its crucial position. Remember this old firefighter adage: The fire goes as the first line goes.

Once the location of the fire has been determined (often a difficult task in itself), the appropriate hose outlet can be selected. The goal is to use one in the stairway closest to the fire to minimize the length of the stretch. One consideration in stairway selection that played a critical role at the July 1990 fire in the Empire State Building is that fire towers (also called "smokeproof towers") created dangerous conditions for advancing nozzle teams. Fire towers most often are found in older (first- and second-generation) high-rise buildings and are designed to provide a natural draft, relieving the stairway of heat and smoke, thereby permitting occupant escape. This draft, however, will also draw fire toward the stairway once the doors are chocked open to permit a handline attack. Using another stairway, even if more remote from the fire, provides a much safer approach. (See "Fire in the Empire State Building," by Bruce Hassett, Fire Engineering, November 1990.)

Some departments require that all standpipe hookups be made on the floor below the fire. A hookup may be permitted on the fire floor in buildings of fire-resistive construction provided the stairway doors are closed and intact. The first officer to reach the fire floor should report information on the position and condition of stairway doors. If it appears that smoke and heat will cause problems at the stair landing on the fire floor, hook up on the floor below. An important point to bear in mind is that if additional hoselines are needed, they of necessity will be attached to hose outlets one, two, and even three floors below the fire or to hose outlets in more distant stairways. Engine companies responsible for the second and third lines should anticipate this fact and bring sufficient extra hose with them. Under no circumstances should a hookup be made to a hose outlet that does not afford the nozzle team protection from heat and smoke, such as in a corridor or hallway.

After the hookup point is chosen, four important operations must be performed at the hose outlet valve before the hose can be attached: To avoid injury, always make sure the hose outlet valve is closed before attempting to remove the outlet cap. In the case of nonautomatic dry standpipe systems, hose outlet valves may be left in the open position due to vandals, and firefighters will have to be assigned to shut these valves so as not to rob valuable pressure from the handline(s).

Remove or adjust the pressure-regulating device if present. PRDs routinely are installed on standpipe outlets to reduce, restrict, or otherwise control pressures. It is possible to find PRDs in buildings that are only six or eight stories in height and, therefore, they should not be considered strictly a problem for "big-city" fire departments. Some types of PRDs can be removed, but others are permanently affixed and cannot be removed--at least not in any reasonable amount of time. Non-removable PRDs must be adjusted to the fully open position. The method by which this is accomplished varies by manufacturer. It is important to recognize that special tools and training may be required to adjust these devices. A third type of PRD exists, and it is the most dangerous. It cannot be removed and is not field-adjustable. It is factory set for a specific pressure; and if that pressure happens to be 55 psi, that`s all you`ll get at the outlet no matter how many pumpers are augmenting the system. The presence of permanently affixed, nonadjustable PRDs should be noted during pre-fire planning inspections, and this information must be disseminated to all affected fire companies.

Flush the system to remove debris that could clog or damage the nozzle. The standpipe system must be flushed thoroughly through the open hose outlet valve. Since NFPA 14 gives no requirements for installing screens or strainers within standpipe systems, garbage and debris often accumulate in the riser and piping and must be flushed so the nozzle does not clog and disrupt the critical mission of the first handline. Flushing the system in this manner also provides the nozzle team with assurance that the outlet valve is properly functional and will allow for pressure adjustments as required.

Attach the in-line gauge to better control nozzle pressure. Once the system has been flushed, the in-line gauge can be attached and the hose hooked up, ready to be charged on orders from the engine company officer. Pressure adjustments then are made by monitoring the in-line gauge and turning the control wheel at the outlet.

A question often arises as to when the handline should be charged. Some departments require that the line always be charged within the confines of the stairway, but this is not always necessary. A more practical approach is to await reports by ladder company personnel performing forcible entry and search operations, since they usually reach the fire floor first and can size up fire conditions--particularly smoke and heat levels--in the hallway. A bedroom or kitchen fire in a high-rise residential building certainly allows the nozzle team to stretch the line dry to the apartment door. In those situations when the fire is more developed (especially if wind is a factor) and the apartment door is open and cannot be closed, charging the line in the stairway may be the only safe option. Well-developed fires in commercial high-rises with open-plan floors wrapping around a center core almost always require that the fire attack be initiated from the safety of the stair enclosure. If any doubt exists, charge the line in the stairway.

SELECTING HOSE AND NOZZLE

In "Return of the Solid Stream" (Fire Engineering, September 1995), I indicated some of the reasons 2 1/2-inch hose and solid-stream nozzles must be used for standpipe firefighting. I will continue this discussion here and provide several real-world examples that serve to reinforce my rather strong opinions on this subject. Unlike firefighting operations in smaller buildings where hose can be hand stretched from engine apparatus to the fire, firefighting efforts involving the use of standpipe systems often are severely limited due to many variables outside fire department control. Standpipe systems may be poorly maintained, vandalized, improperly designed, incorrectly installed, or simply very old. As a means of balancing the many variables that exist in the standpipe firefighting equation against the need for prompt fire control and firefighter safety, the use of 2 1/2-inch hose and solid-stream nozzles is essential.

The single most important reason 2 1/2-inch hose and solid-stream nozzles with 1 1/8- or 1 1/4-inch tips should be used is that, unlike smaller-diameter hoselines and combination nozzles, they are less "pressure sensitive" at the high flows needed to safely handle rapidly developing fires in high-rise and large-area buildings. Critics say that high-volume flows can be achieved using 1 3/4- and two-inch hose, provided the proper nozzle is used and adequate pressures are available. Unfortunately, hose outlet pressures may be very limited due to the design of the standpipe system (remember, NFPA 14 states that only 100 psi need be provided at the most remote floor outlet, and only 65 psi may be available from some older systems); the presence of PRDs that cannot be removed or adjusted to the fully open position; vandalism; and maintenance deficiencies.

Medium-diameter (1 3/4- and two-inch) handlines "eat up" available pressure due to their excessive friction loss per length at high flows. Whereas at a flow of 250 gpm, the friction loss per length of 2 1/2-inch hose is only about six psi; it jumps to 25 psi per length of two-inch hose and a whopping 48 psi per length of 1 3/4-inch hose. If a combination nozzle is used (requiring 100 psi) and three lengths of hose are needed to reach the fire, the outlet pressure using two-inch hose must be 175 psi and with 1 3/4-inch hose; 244 psi is required. Not only are pressures this high unsafe, they often are impossible to attain. A friend was operating the pumps at a standpipe operation with a pump discharge pressure higher than 200 psi. This pressure was needed to supply 1 3/4-inch hose and a combination (fog) nozzle. All of a sudden, he noticed that he was standing in a pool of water. Investigation showed the underground pipe between the freestanding siamese connection and the building had failed, compromising the entire firefighting operation. Failures of this type are more common than many firefighters think, and high pressures are partially to blame.

Even if a 1 1/8-inch solid-stream tip operated at 40 psi is used with a medium-diameter handline, required outlet pressures are still 106 psi for three lengths of two-inch hose and 169 psi for 1 3/4-inch at a flow of approximately 236 gpm. A three-length stretch of

2 1/2-inch hose coupled with a 1 1/8-inch solid-stream tip operated at 40 psi will flow 236 gpm with a required outlet pressure of only 58 psi. A 1 1/4-inch tip at 40 psi will flow 293 gpm. In a test I conducted on various types of nozzles, a 1 1/8-inch tip supplied with only 20 psi at the base of the nozzle inlet produced a 203 gpm stream with an effective reach estimated at 80 feet. At 40-psi base inlet pressure, the flow increased to 298 gpm; and the effective stream reach was well over 100 feet. For test purposes, the nozzles were attached to a ground-based monitor set at a 65-degree angle--not a hand-line. This no doubt increased the flow due to reduced water turbulence at the nozzle inlet because of the vanes in the monitor playpipe. Even assuming the flow results were, say, 15 to 20 percent higher than could be expected from a handline under fireground conditions, no other hose and nozzle combination will provide the low pressure performance and high margin of safety as a solid-stream tip attached to 2 1/2-inch hose.

Another criticism of 2 1/2-inch hose concerns the fact that it is a labor-intensive hand-line and most departments do not have the staffing levels to use it. This argument is severely flawed for a number of reasons. First, it has been my observation that departments that have abandoned 2 1/2-inch line often are the same ones carrying three-inch hose and state that if really big flows are needed, the three-inch can be pressed into service. Three-inch-diameter hose is not a handline--it is a supply line. If staffing isn`t available to handle 2 1/2-inch hose, how can the heavier, stiffer, less maneuverable three-inch line be safely and effectively employed?

Second, many of the problems in handling 2 1/2-inch hose can be overcome simply by training engine company personnel in its proper use. Unlike 2 1/2-inch hose of years past with its heavy double jackets and solid brass couplings, newer types of hose are lighter and easier to carry and deploy. If solid-stream nozzles are used, reaction forces can be minimized while providing unparalleled stream reach and volume of flow. In addition, newer solid-stream nozzles are lightweight, compact, and much less unwieldy than older types. The most effective method of using 2 1/2-inch is for the nozzleman to maintain enough hose out in front so that he has an arm`s length reach to the bale of the shutoff. The backup man then pins the hose to the floor using his hands and leans into the nozzleman`s SCBA cylinder. This provides the nozzleman with adequate stream mobility while easing the reaction force burden. If the line must be moved, gate down, pick up the line, and move forward. Pistol grips may also help the nozzleman maintain effective line control.

Third and last, many departments believe medium-diameter attack lines that can be handled by two firefighters have enough "punch" to handle fires in tall buildings with large floor areas. Let me dispel this belief with some facts about fires in high-rise residential and office buildings. Although most fires in high-rise buildings are of a relatively minor nature, occasionally one occurs that sorely challenges the tactical resources of even the largest fire departments.

A fire on the 18th floor of a high-rise apartment building in the Bronx during November 1994 required the services of three 2 1/2-inch lines operating together, each flowing 250 gpm, to move out of the stairway and suppress the fire, which involved two entire apartments. This firefighting effort was hampered by high winds. On windy days, fires can reach blowtorch proportions on upper floors, especially in residential buildings with narrow, concrete hallways that act like giant nozzles, accelerating the advancing flame front at great and deadly speed. Even on relatively calm days, wind conditions on the upper floors are often dramatically different from those at street level. Some high-rise apartment buildings contain duplex and triplex apartments, and a fire in the Bronx several years ago involving the "down" portion of a duplex apartment on the sixth floor was finally extinguished only by stretching a third handline over an aerial ladder through the fire-apartment window. The two interior lines were beaten back by high heat levels and numerous logistical problems. Fires in the lower-floor areas of duplex and triplex apartments are akin to fighting a cellar fire in the sky.

When discussing fires in high-rise commercial buildings, especially wind-driven fires, personnel needs may exceed severalfold those for residential building fires. Deputy Chief James Murtagh of FDNY, a nationally recognized authority on high-rise firefighting strategy and tactics, has dubbed a well-developed fire in a commercial high-rise building the "100-man fire." If your department or mutual-aid network cannot bring at least 100 firefighters to the scene early on, the fire may not be successfully controlled. Consider that it will require up to three engine companies to place a single handline in service (marrying together three or four engine companies when staffing levels are light is a very wise idea), an additional three engine companies for relief purposes, and perhaps two or three more if the firefighting efforts are drawn out and firefighters begin to fall from heat exhaustion, burn injuries, and depleted air cylinders. Remaining personnel will be used to place additional handlines in service and perform forcible entry, search, ventilation, and other tasks. Certainly, if 100 firefighters and officers are needed to successfully handle a serious fire in a commercial high-rise building, complaints about a lack of personnel to use 2 1/2-inch hose quickly lose credibility.

There is one more area in which solid-stream nozzles provide the nozzle team with an increased level of operational safety--they don`t clog very easily. Can a solid-stream nozzle clog? Absolutely, and my engine company in the Bronx clogged two within several months of each other during standpipe operations. In both cases, rubber handballs lodged within the standpipe system piping were the culprits. Aluminum cans and certain other items also can clog a solid-stream tip. That is why it is so important to flush the system at the outlet before connecting the hose. Even after flushing, there is always the possibility that some entrapped debris may work its way through the riser and hose to the nozzle. Depending on the circumstances, a small rock or other hard object propelled along at high velocity in the water stream could clog or damage the internal workings of a fog nozzle, while the same object will pass through a solid-stream tip.

Other objects can also clog fog nozzles and render them completely useless. The following story was related to me by a fire instructor friend of mine. While he was conducting a basic firefighter training class, students stretched a 1 3/4-inch safety line with an automatic fog nozzle off the dry standpipe in the training building. They charged the line and bled off the trapped air. Some time later, while they attempted to wet down bales of hay with this line, the automatic fog nozzle shut down completely. Later, a second, similar nozzle also shut down suddenly. Fortunately, these lines were not being used to practice extinguishing room fires. The nozzles were removed from the hose. In both cases, the tail and hindquarters of a mouse were found at the nozzle inlet. Apparently, a family of mice had taken up residence in the standpipe riser, and the mechanisms of both nozzles became clogged with mouse entrails. As my friend pointed out to the amazed students, a clogged nozzle is extremely dangerous in an actual fire situation. By using an open-bore tip, the poor mouse would have been hydraulically launched toward the fire in the stream, but the safety of the nozzle team would never have been in doubt.

Safe and efficient operations using standpipe systems require that engine company personnel plan for a host of contingencies. I know of very few standpipe "jobs" that weren`t fraught with difficulties due to the severity of the fire, the condition of the standpipe system, or both. Well-trained and disciplined engine companies not only are prepared for the routine but are able to overcome obstacles to get the job done, even in the face of extreme adversity.

Thanks to the following individuals for their invaluable assistance in preparing this article: Professor Glenn P. Corbett, P.E., John Jay College of Criminal Justice and Fire Engineering technical editor, and Diana Robinson, senior librarian at the New York State Academy of Fire Science. Thanks also to the officers and members of FDNY Engine Company 48 and the following additional FDNY units: Engine Company 38 in the Bronx and Engine Company 34 in Manhattan. This article is dedicated to the memory of Firefighter John Askin, Engine Company 48, who passed away a little over a year ago and who taught me and so many others what it means to be an "Engineman".

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THE CITY OF NEW YORK (NY) FIRE DEPARTMENT`S HIGH-PRESSURE PUMPERS

To supply required handline pressures to standpipe outlets on the upper floors of the tallest "skyscrapers," the City of New York (NY) Fire Department has in service seven "high-pressure" pumpers. Each high-pressure pumper is capable of supplying 500 gpm at a pump discharge pressure (PDP) of 700 psi utilizing a third-pump stage. If building fire pumps should completely fail, at least one and perhaps two 2 1/2-inch handlines with 1 1/8-inch nozzle tips can be placed in service on the 110th floor of either World Trade Center tower (a required PDP of some 650 psi).

Due to the inherent dangers involved in employing pressures so high, FDNY has developed specific procedures to be followed once the incident commander orders the use of high-pressure pumping operations. Section 5 of FDNY`s Firefighting Procedures, Volume 1, Book 5, "High-Rise Office Buildings" lists the following steps to be taken prior to activation of the third pump stage:

-The operation must be supervised by a battalion chief.

-Two engine company chauffeurs must be assigned to the high-pressure pumper--one to operate the pumps and the second to monitor the handheld radio and provide a communications link to the officer in charge due to the high noise levels.

-Only special three-inch, high-pressure hose must be used. All high-pressure hose couplings and other necessary fittings are painted white for identification. They are also noticeably heavier than standard couplings and fittings.

-The high-pressure hose must be attached to a dedicated discharge gate located at the rear or on the side of the pumper opposite the pump control panel.

-The high-pressure hose must be tethered to a "substantial" object to prevent violent whipping should it fail.

-All personnel must remain at least 50 feet from the high-pressure hose, and this area should be cordoned off with rope or barrier tape.

Despite NFPA 14 requirements for the use of "extra-heavy pattern" fittings on standpipe systems in buildings where pressures will exceed 175 psi, the potential for piping or riser failure is so great that an additional FDNY policy requires that all civilian and fire department personnel evacuate the stairway containing the high-pressure riser. Firefighters are not to enter this stairway unless absolutely necessary and are to exit as quickly as possible. The violent failure of a riser subjected to a pressure of several hundred pounds per square inch would no doubt be lethal to anyone nearby.

--ANDREW A. FREDERICKS

THE IN-LINE PRESSURE GAUGE

BY JOHN P. GRASSO

The in-line pressure gauge is a simple piece of equipment that can enhance the efficiency of standpipe operations. The gauge is connected to the hose outlet from which a handline is stretched and allows the firefighter assigned at the outlet to read the pressure being supplied to the line and make adjustments, as required. The firefighter stationed at the outlet is equipped with a portable radio to monitor the progress of the nozzle team and to charge and shut down the line on orders of the engine company officer. Final pressure adjustments are made after water begins flowing and not under static conditions.

Development of adequate fire streams using standpipe systems begins with the engine company chauffeur (or pump operator). In the City of New York (NY) Fire Department, chauffeurs are required to supply 100 psi to the siamese connection plus an additional five psi per floor above grade. The 100 psi takes into account the following:
-friction loss in two lengths (100 feet) of 3 1/2-inch hose used to supply the siamese connection;
-friction losses due to the siamese connection itself, as well as the system riser, piping, and fittings;
-friction loss in three lengths (150 feet) of 2 1/2-inch handline; and nozzle pressure of 40 psi for a 1 1/8-inch solid-stream tip.
If more lengths of either 3 1/2-inch or 2 1/2-inch hose are required, the pump operator must adjust the pump discharge pressure accordingly.

If an in-line gauge is not used, the hose outlet is opened without knowledge as to the pressure being delivered to the nozzle. If the system pressure is excessive, injuries and/or a burst length is possible. If insufficient pressure is being supplied, the flow from the nozzle may be inadequate. By using the in-line gauge to adjust nozzle pressure, the entire operation becomes safer and assures a more effective stream.

The specific pressure required at the outlet is based on the number of hose lengths used and the diameter. The gauge used by Engine Company 48 in the Bronx is labeled with preset pressures for typical hose stretches:
-70 psi for three lengths of 2 1/2-inch hose;
-80 psi for four lengths of 2 1/2-inch hose; and
-90 psi for three lengths of 2 1/2-inch hose and one length of 1 3/4-inch hose.

These pressures were determined through flow tests of actual hose layouts and include a 40-psi nozzle pressure using a 1 1/8-inch tip and a friction loss of about 10 psi per length of 2 1/2-inch hose. While FDNY procedures require the use of 2 1/2-inch hose for all standpipe operations, in certain situations--such as for minor fires in residential occupancies and for overhaul--the use of a lead length of 1 3/4-inch hose equipped with a 1 1/8-inch tip may permit the nozzle team greater mobility without a severe flow reduction. If outlet pressures do not permit its use, the entire stretch is made up of 2 1/2-inch hose.

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STANDPIPE OPERATIONS: FOLLOW UP

BY ANDREW A. FREDERICKS

Just after my article "Standpipe System Operations: Engine Company Basics" (February 1996) went to press, the City of New York (NY) Fire Department experienced yet another tragedy. On January 5, 1996, Firefighter James Williams of Ladder Company 121 died as a result of burn injuries sustained while operating at a fire on the third floor of a standpipe-equipped multiple dwelling. Williams, part of Ladder 121`s forcible entry team, was overtaken by a fast moving flame-front caused by a sudden change in wind direction. The fire, which occurred in the Rockaway Beach section of Queens, gravely illustrates the dangers posed by wind conditions at structure fires. Firefighter Williams died the day after the funeral for Lieutenant John Clancy of Ladder Company 127, who died of burn injuries sustained while searching for squatters at a vacant building fire on December 31, 1995. My (and the entire staff of Fire Engineering`s) deepest sympathies go out to the families and friends of John Clancy and James Williams.

On a much more positive note, two Manhattan engine companies were involved in a very interesting standpipe operation during the height of the blizzard that paralyzed the eastern United States in early January. Shortly after the start of the night tour that began at 1800 hours on January 7, 1996, the captain of Engine Company 22 gave a drill on winter firefighting operations. One of the topics discussed was alternative sources of water supply in the event of frozen or buried hydrants. The FDNY publication Winter Operations mentions the fact that wet standpipe systems may be used as a source of water supply for fires within a standpipe-equipped building and in adjoining buildings.

As it turns out, later that night, Engine Company 22 put into practice what was discussed in the captain`s drill. At 0414 hours, Engine Company 22 responded first-due to a fire on the top floor of a seven-story residential building located at the corner of Madison Avenue and 91st Street. The fire building was not equipped with a standpipe system. The nearest hydrant was frozen; and, due to the extreme weather conditions, promptly locating another hydrant would have been a difficult task at best. Thinking quickly, second-due Engine Company 44 positioned at a nearby standpipe-equipped building, attached a 3 1/2-inch line to a first-floor hose outlet, connected this line to a gated suction inlet, and opened the outlet valve. With an incoming pressure of 60 psi from the gravity tank on the roof and several thousand gallons of water available, Engine 44 then relayed water to Engine 22, whose members extinguished the fire. Although a second-alarm assignment was required at this fire, had it not been for the efforts of the first- and second-due engine companies in improvising to establish a water supply, a much larger commitment of personnel and resources no doubt would have been needed.

One final note: Shortly after I wrote my last article, my engine company in the Bronx inspected a commercial building where a new standpipe system was being installed. This inspection visit enabled me to photograph a standpipe outlet valve with no male threads. As I stated in my article, you can often overcome the absence of threads by carrying a section of pipe threaded with pipe thread on one end and local fire department thread on the other. All FDNY engine companies recently were issued lightweight adapters (male 2 1/2-inch pipe thread to male 2 1/2-inch FDNY thread), which eliminate the need to carry a heavy section of brass pipe in the standpipe kit.

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TACTICAL USE OF FIRE HYDRANTS

BY ANDREW A. FREDERICKS

The prompt control and extinguishment of a serious fire is the single most effective lifesaving action a fire department can perform. Safe and efficient fire control requires water--sometimes lots of it--and in many communities, that water is supplied by hydrants.

In this article, I will identify some of the many conditions limiting the effective use of hydrants, explain techniques for properly testing and flushing hydrants, examine common supply hose practices, and provide numerous tips and suggestions to assist engine companies in securing reliable water supplies under a variety of operating conditions. (For an excellent review of hydrant nomenclature, design features, and applicable standards, see "The Fire Hydrant" by Paul Nussbickel in the January 1989 issue of Fire Engineering, pp. 41-46.)

Before continuing, three important points bear mentioning. First, throughout this article, I refer to the firefighter responsible for driving the engine (pumper) apparatus and operating the pump as the "engine company chauffeur" or, simply, "the chauffeur." In many departments, this individual is called the "engineer" or "pump operator," but in almost all cases these terms are synonymous. Second, when discussing proper techniques for testing, flushing, and hooking up to hydrants, I direct this information at the chauffeur, as this is often his responsibility. In some departments, however, a supply line is laid into the fire from a remote hydrant and a member is left behind to perform the hookup and charge the line when ordered. To avoid injury and ensure an uninterrupted water supply, this individual must adhere to the same testing and flushing procedures as the chauffeur. Third, suburban areas are no longer immune to the urban woes of crime and vandalism, and few communities aren`t faced with budget deficits that impact essential services. Problems that have long affected the availability of working hydrants in the inner city can now be found anywhere.

HYDRANT RELIABILITY

Limitations on the effectiveness of hydrants as a water supply source can be divided into three categories:

-inadequate inspection and maintenance practices by the local fire department and/or water authority;

-limited size and advanced age of water mains supplying hydrants, causing reductions in available volume and static pressure; and

-unauthorized use and vandalism that often render hydrants partially or wholly inoperable.

Although my aim is to examine problems in the first and third categories, I must emphasize the importance of the second category. Knowledge of water main sizes and/or flow test data is a vital part of pre-incident planning and efficient engine company operations. (See "Fire Flow Testing," by Glenn P. Corbett, Fire Engineering, December 1991, p. 70.) Hydrants supplied by mains smaller than six inches in diameter and hydrants that flow less than 500 gpm must be identified to prevent operational difficulties and inadequate fire flows. In addition, the locations of hydrants with the following special characteristics should be noted: situated on dead end mains, requiring special fittings, containing only 2 1/2-inch outlets, and having inoperable drains due to their location in flood plains or areas with high water tables.

Some of the most common problems that result from poor inspection and maintenance practices, unauthorized use, and acts of vandalism are listed below:
numerous open hydrants during summer months, causing critical water pressure reductions;
caps that are difficult to remove;
operating stems that are inoperable or operating nuts damaged so severely that the hydrant wrench cannot be used;
missing caps and damaged or missing threads;
barrels or nozzles clogged with debris;
frozen barrels due to improper drainage in cold weather;
unauthorized contractor use;
hydrants hidden by vegetation;
hydrants buried by snow and ice;
hydrants obstructed by illegally parked cars or trucks, derelict vehicles, or piles of rubbish;
hydrants that have been knocked over;
hydrants that are missing;
hydrants that leak during operations, causing icing problems in cold weather;
hydrants that cannot be shut down at the conclusion of operations; and
threads that are incompatible with hose and fittings carried on engine company apparatus.

INSPECTION AND MAINTENANCE
In many communities, the local water authority regularly inspects and maintains fire hydrants. This does not relieve the fire department of responsibility for performing its own inspections to ensure proper hydrant operations. Engine company personnel should routinely check hydrants in their response areas by removing the cap from the largest outlet (traditionally called the "steamer connection") and thoroughly flushing the barrel to clear debris. Perform such tests during alarm responses, drills, and other outdoor activities so they become habit. Pay particular attention to hydrants with missing caps; debris may have been placed in the barrel. Flush newly installed hydrants thoroughly to prevent rocks trapped in the main and riser from damaging pumps and appliances.

Following are some key points concerning the safe way to test and flush a hydrant. First, on hydrants with the caps securely in place, always check to make sure the hydrant is shut down before attempting to remove the cap. Second, remove the cap from the largest outlet on the hydrant, and flush through this opening to best ensure removal of all entrapped debris. Third, it may be necessary to tighten the other caps to prevent leaks or, more importantly, to prevent the caps from blowing off violently when the hydrant is opened. Fourth, always stand behind the hydrant during flushing operations. Obviously, by standing in front or to the side, there`s a good chance you`ll get wet; but the most important reason for standing behind the hydrant is that rocks and bottles trapped within the hydrant barrel or riser can be forced through the outlet under considerable pressure and become dangerous projectiles. In addition, as noted above, caps can blow off, causing injury.

Another important point concerns the extent to which you must open the operating valve to effectively flush a hydrant. I have observed chauffeurs opening hydrants several turns, allowing water to flow through the uncapped outlet under great pressure. This high pressure may force aluminum cans, glass and plastic bottles, cellophane candy wrappers, and other debris up above the level of the outlets and prevent them from being flushed from the barrel. Then the chauffeurs shut down the hydrant, attach a suction hose, and open the hydrant again to charge the pump with water. All of a sudden--usually just as the first handline is committed to the fire area--a loss of water occurs due to unflushed debris entering the suction line. The attack line goes limp, resulting in a quick reversal of direction by the nozzle crew; the chauffeur instantly panics when intake gauge pressure drops to zero. Proper flushing technique involves opening the hydrant several turns, waiting momentarily, and then closing the hydrant until the discharging stream of water fills approximately one-half of the outlet opening (see illustration on page 64).

VANDALISM AND UNAUTHORIZED USE

Engine company chauffeurs may encounter two types of problems as a result of hydrant vandalism:

The acts of vandalism themselves, which may partially or completely disable hydrants. I routinely encounter hydrants with missing caps, missing threads (most often on the 2 1/2-inch nozzle), missing bolts at the bonnet or break-away flange, operating nuts so worn by unauthorized use they are only slightly larger than the diameter of a pencil, cracked bonnets, frozen barrels due to unauthorized use in winter, and hydrants intentionally knocked over and sometimes even missing altogether.

The measures taken to combat vandalism. In New York City, four major types of anti-vandalism devices are installed on hydrants. Each of these devices requires a special wrench or tool for operation, further complicating the chauffeur`s job. In many cases, two devices are found on the same hydrant--one device to prevent removal of the caps and a second device to protect the operating nut from unauthorized use. In most communities, the only tools necessary to place a hydrant in service are a hydrant wrench and perhaps an adapter or two (National Standard Thread to Storz adapters, ball or gate valves, and four-way hydrant valves being the most common). But in inner-city areas, where vandalism is rampant and hydrant maintenance suspect, many other tools may be required. My engine company in the Bronx carries 14--yes, 14--different wrenches, caps, plugs, adapters, and other tools just to get water from the hydrant. And this does not include the various sizes and types of suction and supply hose needed for the actual hookup.

UTILIZING HYDRANTS--SINGLE ENGINE COMPANY

Typically, either a single engine company operating independently or two or more engine companies operating in concert establish water supplies from hydrants. An individual engine company can establish water supply from a hydrant using one of two common hoselays--the straight or forward lay and the reverse lay.

In the straight or forward lay (sometimes called the "hydrant-to-fire" lay or "in-line" supply lay), the engine apparatus stops at a hydrant before the fire building. A member steps off and removes sufficient hose to "key" the hydrant, also removing the necessary wrenches and fittings. Once the "hydrant" man gives the signal, the engine chauffeur proceeds toward the fire building as the supply hose plays out. The member left at the hydrant then flushes the hydrant, attaches the hose, and charges the supply line on orders from the chauffeur. This method is popular because it permits placement of the engine apparatus close to the fire building, allowing the use of preconnected handlines and deck pipes. It poses several disadvantages, however.

The first disadvantage is that a member is left at the hydrant, reducing personnel available at the fire building to place the first handline into service. A second disadvantage is that if hydrants are spaced more than 500 feet apart, supply hose friction loss can substantially reduce the volume of water reaching the pumps. Many departments believe that dual 2 1/2-inch or three-inch lines will allow movement of suitable quantities of water; but more often than not, only a fraction of the available water is effectively utilized. Large-diameter hose [(LDH) 3 1/2 inches, and larger] will permit better hydrant utilization; but it, too, poses certain problems as discussed in the next two paragraphs.

Another disadvantage of the forward lay is that with the engine apparatus located close to the fire building, ladder company apparatus may be prevented from attaining optimum position. This is particularly true of the second-due ladder company, which often responds from a direction opposite that of the first-due engine. Narrow streets magnify this problem. If the engine apparatus itself does not prove to be an obstruction, supply hose lying in the street may well be. Charged LDH can create a formidable obstacle to later-arriving ladder company apparatus.

Uncharged LDH can cause problems as well. Recently, on Long Island, New York, a tower ladder attempted to drive over a dry five-inch line laid by the first-due engine at a fire in a row of stores. A coupling became caught up in the split rim of one of the rear wheels, breaking the leg of the firefighter at the hydrant and rendering the supply line unusable. An additional caution concerning ladder apparatus and supply lines: Make sure tormentors and outriggers are not inadvertently lowered onto the hose, thereby making a rather efficient hose clamp.

In the reverse or "fire to water" lay, the engine apparatus stops at the fire building first. If members discover a fire requiring the use of handlines, they remove sufficient hose with nozzle attached for deployment in and around the fire building. In multistory buildings, it is critical that enough hose be removed to reach the fire without "stretching short." On a signal from the nozzleman, officer, or other designated member, the chauffeur proceeds to the next hydrant, tests it, flushes it, and performs the supply hose hookup. If members encounter a serious fire, they may "drop" a second handline at the fire building for use by another engine company or lay a large-diameter line to supply an incoming ladder pipe or tower ladder. The reverse lay is used by the City of New York (NY) Fire Department almost exclusively (where it is simply called a "backstretch").

Advantages of the reverse lay include leaving the front and sides of the fire building open for placement of ladder company apparatus; efficient use of personnel, because the chauffeur is able to perform the hydrant hookup alone; and better utilization of the available water supply, because the engine is at the hydrant.

One disadvantage of the reverse lay is that any apparatus-based master stream device is removed from the tactical arsenal, unless the hydrant happens to be close to the fire building. Another disadvantage is the potential for long handline lays and the need for high pump discharge pressures, which can be overcome by "filling out" any stretch of 1 3/4- or two-inch line with 2 1/2-inch hose to reduce friction loss. This method also allows the option of disconnecting the 1 3/4- or two-inch hose and employing the bigger handline should conditions deteriorate and its use become necessary. Attaching a gated wye or "water thief" appliance to the 2 1/2-inch hose provides still more flexibility. In FDNY, a maximum of six lengths (300 feet) of 1 3/4-inch hose is permitted to keep the pump discharge pressure (PDP) within safe and reasonable limits. Many companies carry only four lengths, further reducing the required PDP.

Another disadvantage of the reverse lay is that it often precludes the use of preconnected handlines. While this is true and preconnects do allow for rapid handline deployment, the fire service has become overly dependent on them, and few firefighters today have the ability to accurately estimate handline stretches. Probably the biggest problem with preconnected lines is the "one-size-fits-all" approach. This can cause a significant delay in getting water on the fire when the line isn`t long enough. Unless provisions are made beforehand to extend preconnected lines--as is often accomplished through the use of gated wyes and manifolds--fires can rapidly grow out of control.

On the other hand, sometimes preconnected lines are too long. At one recent fire, the first-due engine was positioned in front of the fire building, and only about 100 feet of hose was needed to reach the fire and effectively cover the one-family structure. Unfortunately, both preconnected lines carried in the crosslay hosebeds were 200 feet in length, and excessive kinks caused a loss in water significant enough to force the nozzle team off the fire floor.

Perhaps the best approach is to outfit each engine apparatus with hose loads that allow for both a straight lay and a reverse lay. This approach permits a high degree of tactical flexibility when selecting a hydrant and positioning the apparatus.

UTILIZING HYDRANTS--TWO ENGINE COMPANIES

Up until about the 1950s, many engine companies were "two-piece" companies consisting of a hose wagon, which carried hose, fittings, and nozzles and an engine, which was equipped with a pump and suction connection. The hose wagon would take a position close to the fire building to facilitate shorter handline stretches and to afford use of its "wagon pipe." The engine would supply the wagon with water from a hydrant. Even today, with near universal use of triple-combination pumpers, water supply procedures in many fire departments call for the first-due engine to position near the fire building and, unless a hydrant is close by, the second-due engine to connect to a hydrant and supply the first.

The major advantage in using two engine companies to establish a water supply is positioning the first-due engine near the fire building for rapid deployment of preconnected handlines. Because of minimal staffing levels in many fire departments, it is imperative that handline stretches be kept as short as possible. In addition, due to long response distances, many fire attack operations are initiated with booster tank water until the second-due engine arrives to establish a positive water supply.

An advantage of this method over the straight or forward lay is that where hydrant spacing exceeds 500 feet, the second-due engine can relay water to the first and overcome any friction loss limitations in the supply line. The use of large-diameter hose further increases the efficiency of water supply operations. This method will also prove advantageous in very hilly areas when the fire building is at a higher elevation than the hydrant and when static pressures are weak. Other situations that might require two engine companies working together to establish a water supply follow:

The fire is in a remote area and a considerable distance from the nearest hydrant.

A frozen or defective hydrant is encountered and repositioning the first-due engine is not possible.

Hydrants are buried by snow and difficult to locate.

Hydrants are obstructed by vehicles or rubbish.

The actual procedures to be used by the two engine companies in establishing a water supply will depend on street conditions, the need for ladder company access to the fire building, and the direction of response of each engine. The following options are available:

The second-due engine can pick up a supply line already keyed to a hydrant by the first-due engine, hook up, and charge the line; the second-due engine can pass the first and lay out to a hydrant; the second-due engine can back down the street to the first and lay out to a hydrant; or a supply line may be hand stretched if time and distance permit.

The most significant disadvantage in using two engine companies to establish a continuous water supply from a single source is that it amounts to placing all your water supply eggs in a single basket. In the event of a mechanical failure, clogged suction line, or defective hydrant, there is no water supply redundancy as would be the case if individual engine companies secure their own hydrants. It is my recommendation that if a third engine is not normally assigned on structure fire alarms, it be requested as soon as possible. The third engine should position at another hydrant in the vicinity of the fire building and prepare to quickly deploy handlines or provide an emergency supply line as needed.

POSITIONING AT HYDRANTS

No matter what type of water supply procedure normally is employed, anytime a hydrant is located near the fire building its use should be considered. This usually eliminates the need for the second-due engine to supply the first and frees the second engine to find its own hydrant, thereby providing water supply redundancy. It is important that before committing to its own hydrant, the second-due engine should ascertain that the first-due has a "good" hydrant and is not stranded without continuous water. Communication between the engine company officers and/or chauffeurs is essential.

The hydrant the first-due engine company selects for use should be as close to the fire building as possible but not so close as to place the chauffeur and rig in danger. For an advanced fire on arrival, using a deck pipe can prove advantageous; but consider the potential size of the collapse zone and the problem of radiant heat. Other dangers include dense smoke and falling glass, which can cause serious injuries and severed hoselines.

At many fires, the dangers of collapse and radiant heat do not exist, so the only considerations in hydrant selection are the amount of hose required to reach the fire and the need for unobstructed access to the fire building by ladder company apparatus. When streets are narrow or crowded with parked cars, engine company positioning can pose a challenge. How can the engine chauffeur get his rig out of the way of approaching ladder apparatus and still facilitate quick and efficient handline placement at the fire?

The answer to this question involves two related considerations--the specific pumper suction inlet to be used and the length and type of suction connections (hose) available. Many modern engines are equipped with a gated front suction. A section of "soft sleeve" is often preconnected for immediate use. (Some pumpers are equipped with rear suctions--either in place of a front suction or in addition to it.) While preconnecting the suction hose is not a problem, the tendency to always utilize the front suction because of its convenience can be. On narrow streets, use of the front suction often requires the engine chauffeur to "nose" his rig into the hydrant, blocking the street to the detriment of later-arriving apparatus. The shorter the section of soft suction hose, the greater this problem. Short sections of soft suction hose also present the problem of kinks unless the engine is ideally positioned, which is seldom possible.

Chauffeurs must be prepared to use any of the suction inlets on their apparatus based on a size-up of possible positioning options. Pumpers rated at 1,000 gpm and greater have a large (master) suction and a 2 1/2- or three-inch gated inlet on each side. Side suctions are efficient because they allow the engine apparatus to parallel park next to a hydrant, keeping the street unobstructed. If a semirigid suction connection is used in lieu of a soft suction, kinking will not be a problem. If a semirigid suction hose is not available, consider wrapping the soft suction hose around the back of the hydrant to reduce kinking. The soft suction hose must be long enough to permit this. Another consideration in the use of the side suction is that side suction intakes are not gated. On at least two occasions when I attempted to open a front suction gate valve, the threaded rod between the gate and the control wheel at the pump panel unscrewed as I turned it, rendering the front suction useless. Fortunately, this never occurred in a critical situation. Following are some additional tips and suggestions for best utilizing hydrants:
Do not overlook gated inlets; they may prove extremely valuable when snow piles, cars, and rubbish obstruct a hydrant, preventing use of a soft or semirigid suction connection. A 50-foot "fly line" of three-inch or larger hose can be carried to help reach the hydrant in these situations.

When pressure problems develop, as is often the case at large fires, multiple alarm engine companies should hook up to hydrants with a length of hard suction hose to eliminate the danger of a collapsed soft or semirigid suction hose.

Consider attaching a ball or gate valve to a 2 1/2-inch hydrant nozzle in addition to using the steamer connection. You can then run a supply hose to a gated inlet, providing additional capacity, which may come in handy at fires in vacant buildings, attached or closely spaced wood-frame buildings, and large-area "taxpayers."

In high value districts, where hydrants are closely spaced, it may be possible for one engine to connect to two hydrants. Some cities still maintain high-pressure water systems, which may permit two engines to share a hydrant.

During the winter months, consider covering all exposed suction hose couplings with aluminum foil to prevent snow and ice accumulations, which could clog the hose or prevent the female swivels from spinning freely.

THE TWO MINUTES OF TERROR

A veteran chauffeur in FDNY Engine Company 48 coined the phrase "the two minutes of terror" when describing the experience of the first-due engine chauffeur during the initial two minutes at the scene of a structure fire. Within two minutes (or less), the chauffeur must position the engine apparatus near a hydrant, scramble to test and flush the hydrant, attach the suction hose, get water into the pump, hook up the handline to a discharge gate (or ensure the preconnected hosebed is cleared of hose), and engage the pump. Hopefully, all these tasks are completed before the officer calls for water. One nickname you never want as a chauffeur is "Sahara."

If this isn`t enough responsibility, in inner city areas, the two minutes described above are even more terrifying as the answers to four important questions are sought:
1. Is the hydrant where it`s supposed to be, or is it missing?
2. If the hydrant is present, is it upright and attached at the break-away flange?
3. If the hydrant is upright and attached, will it flow water when tested, or is it broken or frozen?
4. If the hydrant is operational, can the caps be removed in a reasonable amount of time to permit attachment of the suction hose?

To better understand the difficulties encountered with hydrants located in areas of high vandalism and why these four questions are so important, consider the following three incidents.

A chauffeur in a busy south Bronx engine company responded first due to a working tenement fire. After stopping in front of the fire building to permit the stretching of a handline, he proceeded down the block to find a hydrant. The first "hydrant" he found was not actually a hydrant but merely the lower barrel protruding from the ground--the hydrant itself was completely missing! As he continued his search, the next hydrant he came upon was lying on its side. Finally, he saw an upright hydrant almost one and a half blocks from the fire building; fortunately, it proved operational. The rest of his company grumbled for days about the several extra lengths of hose they had to drain and repack, but the chauffeur did his job and secured a continuous water supply in the face of extreme difficulty.

A veteran chauffeur from the northeast Bronx arrived to find heavy fire venting from the front first-floor windows of an occupied private house. A hydrant was located on the sidewalk nearby, and it appeared that the hookup would be quick and easy. But appearances can be deceiving. After the chauffeur placed a wrench on the operating nut and applied leverage to open it, the entire hydrant fell over onto its side! But before proceeding to the next hydrant, he notified his officer via portable radio that there would be a delay in the water supply (and notified the second-due engine company, in case its assistance was needed).

In addition to communicating any delays or other problems, it is imperative that when a handline is being supplied by water from the booster tank, the officer or nozzle team must be made aware of this fact. Once hydrant water is available, this information also must be communicated to the officer and nozzle team so they may alter their tactics accordingly. One more point: Good chauffeurs always maintain a full booster tank during operations as a safety measure should a loss of hydrant water occur.

I will provide a personal example of the difficulty often encountered in trying to remove the large cap from the hydrant steamer connection. Due to anti-vandalism devices and caps stuck or frozen in place, chauffeurs in my company routinely strike every cap with a maul, using several sharp blows. Striking the cap in this fashion jars loose debris trapped in the threads and usually permits the caps to be removed easily. Several months ago, I was detailed to drive an engine company in upper Manhattan. At about

5:30 a.m., we were dispatched first due to a fire in a multiple dwelling that subsequently turned out to be a fatal fire. Out of habit, I had placed the eight-pound maul in a familiar location on the rig at the start of the tour in case it was needed. Sure enough, it was necessary to strike the cap on the hydrant I selected several times before the cap could be removed with the wrench. If several sharp blows with a maul (or back of an axe, if a maul is not available) doesn't loosen the cap sufficiently to allow removal, you can slip a length of pipe over the handle of the hydrant wrench to gain more leverage. I do not advise striking the handle of the wrench itself, I have seen wrenches bend and crack.

"START WATER"

The effective utilization of hydrants requires forethought, training, and fast thinking at the scene of a fire. Engine apparatus should be equipped for a variety of water supply contingencies, and chauffeurs should be provided with portable radios to improve fireground communications. Many excellent texts on engine company operations and water supply procedures are available; consult them for more information on the hoselays discussed in this article and other related subjects.

A veteran Bronx fire officer once said that the entire job of the engine company can be summed up in four short phrases: "Start a line. Start water. Shut down. Take up." Obviously, this is a gross oversimplification. But good engine chauffeurs can make it seem this easy, even when the hydrant is "bad" and the fire is "out three windows."

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THORNTON'S RULE

RESPONSE BY ANDREW A. FREDERICKS

I was compelled to pen these comments concerning an article by John D. Wiseman, Jr., "Thornton`s Rule and the Exterior Fog Attack: A Perspective" (July 1996). Based on Wiseman`s conclusions, I guess we can look forward to wearing rubber turnout coats and riding the back step again. Fighting fires using fog streams directed through window openings was common in the 1950s when the "indirect" and "combination" methods of fire attack became popular. But it is not the 1950s and aggressive, interior firefighting is the hallmark of modern fire departments across the nation. To fight any structure fire other than from the interior when conditions are favorable to an interior attack and a thorough search of the building for victims has not been concluded does not merely constitute incompetence; it smacks of utter cowardice.

Despite his many years of service, Wiseman has apparently failed to understand a basic tenet of structure firefighting: Hoselines are not stretched and operated simply to extinguish fire. Hoselines are stretched and operated to save lives--civilian and firefighter--by separating the fire from any trapped occupants; safeguarding the means of egress (hallways and stairs); confining the fire to limit extension; and extinguishing the fire to end production of smoke laden with heated, toxic, and highly flammable combustion gases. The late chief Emanual Fried stated this principle very succinctly some 25 years ago: "Regardless of strategic dictates, the safety of human life should always be the strongest motivating factor in the placement of a hose stream."

I have talked at length with Keith Royer. He explained that the Iowa formula is concerned strictly with estimating required fire flow for controlling a fire in the largest room or section of a building or structure. (For an excellent discussion of the Iowa rate-of-flow formula, see "Iowa Rate of Flow Formula for Fire Control," Fire Engineering, September 1995.) Fire flow needs for complete extinguishment, exposure protection, and fire extension are not taken into account. And occupant life safety was not an issue addressed by the Iowa researchers. For this reason the type of stream to be used (fog, straight, or solid) and the point or points for fire stream application are left up to the individual fire department. Only at this level can decisions about how best to protect the lives of trapped victims and searching firefighters be made. Just as municipal fire departments perform not one but two searches (primary and secondary) at every structure fire to be certain all potential victims have been accounted for, hoselines must be positioned with the intent to save lives. Sticking a nozzle through the window does not usually accomplish this most basic firefighting objective. This leads us to Thornton`s Rule.

What Thornton discovered before World War I was that in any oxygen-regulated fire environment, heats of combustion will be approximately the same for a variety of organic (carbon containing) liquids and gases. In the 1970s, Huggett extended Thornton`s research and found that the heat of combustion for a wide range of organic solids is also relatively constant and is a factor of the oxygen available for consumption within the fire compartment. This means that regardless of the type of material--be it hydrocarbon- or cellulose-based--heats of combustion do not vary substantially.

Based on the research findings of Thornton and Huggett, scientists have created methods of calculating heats of combustion for various substances based on the amount (or mass) of oxygen consumed. In practical terms, scientists can analyze the combustion products produced by a material burning under strictly controlled conditions in a calorimeter and determine its heat of combustion. Unfortunately, as many scientists and fire protection engineers point out, application of the oxygen consumption method outside the laboratory is not straightforward. Due to problems in testing and measuring techniques (several different types of calorimeters and measurement instruments are in use) and the fact that a laboratory test is being transposed to the highly complex, infinitely variable real world, all results must be viewed very carefully.

Wiseman ignores another critical point--uncontrolled ventilation. In stochiometric calorimetry, the amount of available oxygen is controllable. Not so at a structure fire, where ventilation parameters are highly variable and may change many times during the course of a fire. And when ventilation is increased, another factor must be considered--the rate at which different materials liberate heat. It is one thing to say that for a given quantity (mass) of available oxygen, two materials--one hydrocarbon-, the other cellulose-based--will have approximately equal heats of combustion. But when provided with increased ventilation, hydrocarbons generally will liberate heat at a rate faster than cellulosic materials. As a consequence, we can expect that rollover and flashover conditions will be achieved in much less time.

Consider this example taken from real-world experience. A ladder company arrives at an early morning apartment fire and begins a primary search. A fire is discovered in the kitchen, but there is no door to close and isolate the fire. Initially, the fire appears small and docile--windows are still intact, heat conditions tolerable. The search team penetrates deeper into the apartment upon radio reports of a missing child. Suddenly, a thermal pane window fails, introducing a fresh supply of oxygen. The oxygen mixes with the highly heated carbon monoxide gas, causing the fire room and hallway to become a mass of orange flames. As the searching firefighters drop to their stomachs and begin reciting the Our Father, the engine company`s quick-acting nozzle team drives the fire back with its powerful solid stream, preventing severe burns to the search team members.

The fire service did not abandon booster lines and 1 1/2-inch hose based on exterior application of water fog. The advent of 1 3/4-inch and two-inch hose was inevitable given the dangers of rollover and flashover faced by firefighters advancing hoselines inside highly heated structures.

Wiseman also reminds us that, according to the Iowa formula, if the correct flow is provided and the water is applied at the proper point(s), the nozzle need only be opened for 30 seconds or less to achieve control. Royer and Nelson stated that by keeping the nozzle open much longer than necessary to "black out" the fire would overcool the fire area and negate subsequent ventilation efforts. Unfortunately, this does not reflect the reality of most interior firefighting operations. Closing a nozzle immediately after knockdown requires discipline and a degree of experience many of today`s nozzlemen simply do not have. In addition, even after knockdown, the nozzle must sometimes be kept open to cool a burning room to permit search and overhaul operations. Apparently, Wiseman has yet to experience the tremendous heat that radiates from lath and plaster walls or concrete ceilings once a post-flashover fire has been controlled.

Wiseman is entitled to his opinion, but he was educated in a much different school of firefighting than I was. If we adopt this approach, it is back to the 1950s. Exterior fire attack will become the rule, and victims will be an afterthought. We can return to the use of 3/4-inch booster line and store our sophisticated turnout clothing and SCBA away in the closet. I`m sure the public we are sworn to protect will understand, as will their attorneys.

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THE 2 1/2 INCH HANDLINE

BY ANDREW A. FREDERICKS

For decades, 2 1/2-inch hose was the mainstay of fire departments across the nation. Despite the widespread availability of smaller, lighter 1 1/2-inch hose after World War II, many fire departments continued to use 2 1/2-inch hose exclusively for interior and exterior firefighting. Urban fire departments in particular--confronted with large factories, high-rise office buildings, and residential neighborhoods crowded with combustible housing stock--found the limited flow of 1 1/2-inch hose insufficient. In New York City, 2 1/2-inch hose was required for all structure firefighting up until the late 1960s.

During the early 1970s, a combination of factors caused a reevaluation of 2 1/2-inch hose as the handline of choice for many fire departments. One factor was the sudden, dramatic increase in fire activity throughout urban America. Increased fire activity required handlines that could be deployed swiftly and drained and repacked with a minimum of effort. Recently introduced 1 3/4-inch hose met these specifications. With the appearance of 2-inch hose during the late 1970s, still more fire departments abandoned their allegiance to the "deuce-and-a-half."

A second factor for the reevaluation of 2 1/2-inch hose was staffing. Firefighter layoffs, resulting from the near-bankruptcy of some cities, decimated the ranks of career fire departments. The membership rolls of many volunteer departments also began to dwindle. Bending, maneuvering, and advancing 2 1/2-inch hose are normally difficult, but the painful staffing reductions made them even more so.

A third factor was the introduction of various experimental technologies to the fire service, including friction-loss reduction agents, which were popular in the early to mid-1970s. These agents, which allowed flows of 250 gpm through 1 3/4-inch hose, convinced many chief officers that 2 1/2-inch hose no longer was needed. By the mid-1980s, the most potent offensive weapon at the disposal of the fire service had been relegated to second- and even third-class status among available handline options. Some fire departments retired it altogether.

With all these arguments against 2 1/2-inch hose, can a valid case be made for its continued survival as part of the municipal fire service arsenal? The answer is unequivocally yes, and the balance of this article makes such a case.

LIMITATIONS OF 1 3/4-INCH HOSE

As James J. Regan points out in his thought-provoking article, "1 3/4-Inch Hose: The Booster Line of the `90s?" (Fire Engineering, September 1993), the main reason for developing 1 3/4-inch hose was its greater speed and maneuverability during fire attack operations within cramped tenements houses in New York City. This handline could be deployed and advanced much more quickly than 2 1/2-inch lines without suffering the 50 percent flow reduction resulting from the use of 1 1/2-inch hose. This history has apparently been lost on many fire service members; 1 3/4-inch hose is erroneously viewed as the answer to almost all firefighting problems. As Regan observes: "We have seen 1 3/4-inch hose used as a replacement for 2 1/2-inch hose in fireground situations that the original proponents and developers of the small-diameter hose did not contemplate and, in all likelihood, would not support."

Fireground flows from 1 3/4-inch hose should range from 150 to 190 gpm. The City of New York (NY) Fire Department (FDNY) considers 180 gpm the ideal flow from 1 3/4-inch lines in terms of fire extinguishment capability and handling characteristics. Some members of the fire service (myself included) suggest that actual fireground flows from 1 3/4-inch hose are somewhat less than the 150-gpm minimum given above. The main reason for this is widespread under-estimation of the friction loss in 1 3/4-inch hose at flows of 150 gpm or more.

How many pump operators have been taught that the pump discharge pressure (PDP) for a 150-foot preconnected line of 1 3/4-inch hose fitted with a 100-psi fog nozzle is only 120 to 130 psi? At a PDP of 120 psi, a flow of about 100 gpm is delivered--simply not enough water for interior fire attack operations. I contend that handline flows of less than 150 gpm are insufficient and potentially dangerous. A target flow of 175 gpm is much safer. To flow 175 gpm through 1 3/4-inch hose, a friction loss of at least 20 psi per 50-foot length must be overcome. In the example above (150-foot preconnected line with 100-psi fog nozzle), the PDP must be at least 160 psi.

THE TWO-FIVE SYNDROME

There is a movement afoot to promote the notion that only two sizes of hose are needed: 2-inch for handlines and 5-inch for supply lines. Some departments never adopted 1 3/4-inch hose and instead converted directly from 1 1/2-inch to 2-inch when it became widely available. Two-inch hose offers a higher practical flow limit than 1 3/4-inch (about 220 gpm vs. 190 gpm) while maintaining the handling and maneuverability characteristics that have made 1 3/4-inch hose so popular. Despite an increased flow over 1 3/4-inch hose, 2-inch hose is still no substitute for the 2 1/2-inch handline in many situations.

When comparing flows from 2-inch and 2 1/2-inch hose, 2 1/2-inch hose will deliver on average about 50 gpm more at the same PDP--and possibly as much as 100 gpm more--depending on the size of the nozzle tip used. This is a direct result of a much higher practical flow limit for 2 1/2-inch hose (around 330 gpm). Obviously, fireground situations will arise at which the reduced flow from 2-inch hose may make a critical difference in controlling the fire. And, like 1 3/4-inch hose, the friction loss per length of 2-inch hose is often underestimated. To flow 210 gpm through 2-inch hose, a friction loss of between 15 and 18 psi per 50-foot length must be calculated. Just as with 1 3/4-inch hose, some pump operators believe that a PDP of 120 psi is sufficient for a 150-foot preconnected 2-inch line equipped with a 100-psi fog nozzle. A PDP this low will produce a flow of about 125 gpm. If only 125 gpm is desired, you might as well return to using 1 1/2-inch hose.

If a pump operator attempts to deliver the 250 to 260 gpm normally expected from 2 1/2-inch hose through a 2-inch line, friction loss quickly becomes excessive and the required PDP goes through the roof (especially when 100-psi fog nozzles are used). This increases the chances of a burst length, makes the hoseline extremely rigid and difficult to bend, and increases the nozzle reaction burden. Consequently, the advantages of better handling and maneuverability offered by 2-inch hose are lost, and both fireground safety and efficiency are compromised.

IMPACT OF REDUCED STAFFING

The staffing that existed in fire departments across the country before the reductions that occurred during the early to mid-1970s has never been fully restored. Today, the typical career engine company is staffed with an officer and only two firefighters, including the chauffeur/pump operator. This leaves only two personnel, the officer and a firefighter, available to get the first handline into service. If the officer must break away from the line to complete a search, the firefighter is left alone to struggle with the line and try to keep it moving until help arrives. And in some suburban and rural areas, help may be five, 10, or even more minutes away.

Many volunteer departments, especially on weekdays, also suffer from staffing shortages, causing the burden of stretching and operating the first handline, in many cases, to fall on the shoulders of one or two firefighters. Mutual aid can be summoned, but it will take time for it to arrive. In these situations, the tendency to always stretch a 1 3/4- or 2-inch handline is quite understandable. Fire departments also get away with it because most fires occur in residential buildings with small rooms ideally suited for the use of 1 3/4- and 2-inch lines. This is called the "residential room fire mindset." Unfortunately, problems arise when a fire is beyond the flow capabilities of the smaller-diameter handlines. Even when 2 1/2-inch hose is carried by engine companies, often no one thinks to stretch it or no one has been trained in its effective use.

"SLIPPERY WATER"

Forward-thinking fire chiefs greeted the advent of friction-loss reduction agents in the early 1970s with great optimism. For a variety of technical and political reasons, these agents fell into disfavor and quickly disappeared from the scene. Recently, attention has been focused on various types of Class A foams, and they represent first and second cousins to the "slippery water" agents of 25 years ago. A discussion of Class A foams, however, is beyond the scope of this article.

ADVANTAGES OF 2 1/2-INCH HOSE

I will not dispute that 2 1/2-inch hose is difficult to use. Many a big, burly firefighter has been humbled by its sheer size and weight. The water alone contained in a 50-foot length of 2 1/2-inch hose weighs some 106 pounds (compared with 52 pounds for 1 3/4-inch hose). But no combination of smaller handlines can duplicate the volume, reach, and pure knockdown power of a single, well-placed 2 1/2-inch line. In addition to its high volume flows (between 250 and 320 gpm) and long stream reach, 2 1/2-inch hose provides the following benefits when used with a 1 1/8-inch solid stream tip: low friction loss per 50-foot length (only about six to eight psi at 262 gpm), exceptional penetrating power due to hydraulic force of stream, little premature water vaporization in highly heated fire areas, easy reduction to smaller-diameter hand-line(s) after knockdown, and much better maneuverability than 3-inch hose (sometimes used as a handline) or portable master stream devices.

To realize each of these advantages, personnel must be thoroughly trained in the use of 2 1/2-inch hose as a mobile, highly effective handline. In addition, to avoid the problems caused when each of several engine companies stretches its own smaller-diameter handline at large fires, an incident commander should not hesitate to team up two, even three, engine companies to place a 2 1/2-inch line into service and ensure its mobility. In previous articles, I have questioned the practice of using 3-inch hose as a handline, especially by chronically understaffed departments. I`ve heard chiefs argue for the use of 3-inch hose as a "blitz" attack line, but its weight, its size, and the extreme difficulty it poses in handling should cause a rethinking of this approach. In practical terms, 2 1/2-inch hose provides just as much water but is less fatiguing to use and more maneuverable, increasing its tactical flexibility.

Some departments that use 2 1/2-inch hose equip their handlines with high-volume fog nozzles (250 to 300 gpm). This practice decreases the effectiveness of the 2 1/2-inch handline because the nozzle reaction (in straight-stream position) may be as much as 125 pounds or more at a flow of 250 gpm. A nozzle reaction this high rapidly fatigues the nozzle team and requires a large commitment of resources to keep the line moving. If the nozzle is changed to a fog pattern, the reaction force is reduced, but the reach of the stream is lost, and a long reaching, high-volume stream is the reason 2 1/2-inch hose is employed in the first place. Fog streams also turn readily to steam and never reach the burning solid fuels. Even very compact fog streams (commonly called "straight streams") will suffer more premature water vaporization than solid streams when directed into highly heated fire areas.

Some suggest that when 1 3/4- or 2-inch hose is "outgunned," the solution is to employ lightweight, portable master stream devices, bypassing the 2 1/2-inch hose altogether. Fireground flows now have jumped from 150 to 200 gpm all the way up to between 400 and 800 gpm. Is there not room for some middle ground here? In addition, just how advantageous can a portable master stream device be when it must be secured in position for safe operation and does not provide the mobility offered by a handline? Portable master streams have their place, but not at the expense of 2 1/2-inch hose.

TACTICAL CONSIDERATIONS

FDNY standard operating procedures call for the use of 2 1/2-inch hose at fires involving retail stores, factories, warehouses, and industrial occupancies. Below-grade fires in commercial buildings also require that 2 1/2-inch hose be used. FDNY requires that 2 1/2-inch hose be stretched as the first handline during all standpipe system operations. It can also be stretched on order of the engine company officer any time fire conditions appear to indicate its use.

When should a 2 1/2-inch handline be used instead of smaller hose? One way to remember those situations that call for 2 1/2-inch line is to use the mnemonic device "ADULTS," created by an FDNY firefighter while studying for the lieutenant promotional exam:

-Advanced fire on arrival

-Defensive operations

-Unable to determine extent (size) of fire area

-Large, uncompartmented areas

-Tons of water

-Standpipe system operations

Advanced Fire on Arrival

Any time you encounter an advanced fire condition on arrival, consider deployment of a 2 1/2-inch handline. An advanced fire condition often precludes immediate entry into the fire building. Even private dwellings may warrant an attack with 2 1/2-inch hose, especially when a large volume of fire involves the front porch or first floor, or if combustible siding is burning and threatening nearby exposures. While the use of master stream devices at fires in occupied residential buildings is not recommended, the same cannot be said about 2 1/2-inch hose. After all, it is a handline and can be advanced into the building to complete extinguishment once the fire has been given a quick dash from the outside.

If the 2 1/2-inch line itself proves too difficult to bend and maneuver within the confines of a residential building (which is almost always the case), two potential solutions exist. In the first solution, the 2 1/2-inch line can be shut down and abandoned and a smaller-diameter handline can be stretched for interior operations. The second solution is to shut down the 2 1/2-inch line, remove the nozzle tip, and extend the line with smaller hose. One caution with this second method: If the shutoff handle becomes submerged in water or is buried by a fallen plaster ceiling, it may inadvertently be bumped and closed by a passing firefighter. To ensure the safety of the nozzle team, station a firefighter at the shutoff. If this is not practicable, secure it open with a short length of rope or a hose strap. (This practice should also be followed when 2 1/2- or 3-inch hose is used with a gated wye or manifold to extend the length of preconnected handlines.)

If an engine company opts to use a master stream attack when encountering an advanced fire condition, two issues need to be addressed. The first is the speed with which a portable master stream device can be set up for an attack on the fire. Even new, lightweight portable deluge guns require that a supply line be preconnected and that their deployment be well-rehearsed at drills for effective use. The second issue involves use of an engine-mounted deck pipe. Depending on circumstances, heavy fire venting from a storefront might suggest a quick shot from the deck pipe, but will the height of the deck pipe above the ground allow for penetration of the stream into the fire building? The stream will not be effective if most of the water is directed at the floor 25 feet inside the entrance door. In both of these cases, stretching a 2 1/2-inch handline fitted with a large tip (1 1/4-inch) might well be the fastest means of getting water where it is needed to quickly darken down the fire.

Defensive Operations

When an offensive fire attack fails or the fire building is a "loser" right from the start (unoccupied vacant, with a history of previous fires), use of 2 1/2-inch handlines from outside positions is an effective tactic. A 2 1/2-inch line is far more mobile than any master stream device and can be placed in service rapidly. It can be stretched and operated from windows and rooftops of adjoining buildings, alleyways, and rear yards--areas often inaccessible to master stream placement. If a harder-hitting stream proves necessary, two 2 1/2-inch lines that already have been stretched can be combined to supply a portable deluge set, providing flows of 500 gpm and more. Firefighters operating from outside positions must constantly be aware of the danger of collapse. The size of the "collapse zone" is dictated by the height and construction of the fire building. Using the long reach of the 2 1/2-inch stream is essential to keep firefighters out of the danger area. Avoid the temptation to creep into the collapse zone for a better shot at the fire. Line and sector officers must exercise close supervision in these cases due to the inherent aggressiveness displayed by most firefighters. If the stream isn`t reaching the desired objective, reposition to another safe location or consider the use of a master stream device, as discussed above.

Unable to Determine Extent of Fire Area

If the size of the potential fire area cannot be determined initially or if the size (volume) of fire within a particular occupancy is unknown, use the 2 1/2-inch line. The 2 1/2-inch handline is needed for its high-volume flow and because it can deliver its high flow a distance of some 70 feet or more. With a solid-stream tip, the water can be directed into highly heated fire areas without significant loss of volume due to premature water vaporization. If a size-up of the fire area or the amount of fire reveals that the fire can be handled with smaller hose, the 2 1/2-inch line can be put aside or reduced to 1 3/4- or 2-inch hose, as previously described.

Large, Uncompartmented Areas

Large, undivided areas require the volume, reach, and penetration offered by the 2 1/2-inch line. The wide-open floor spaces found in supermarkets, bowling alleys, and warehouses are common examples. Most of these occupancies also feature high ceilings. High-ceiling areas allow large amounts of heated fire gases to collect while giving little indication of their presence at floor level. These gases can ignite suddenly, and the streams produced by smaller handlines may not be sufficient to push back the flames, cool the ceiling (which may be combustible itself), and penetrate to the burning solid fuel. The reach provided by a properly pressurized 2 1/2-inch line often allows it to be operated from the safety of a doorway until the ceiling gases have been dealt with and advance is possible.

Tons of Water

A 2 1/2-inch handline with a 1 1/8-inch solid-stream tip will deliver approximately 260 gpm at a nozzle pressure of 50 psi. With a weight of about 8.33 pounds per gallon of fresh water, that`s more than one ton of water per minute. Lobbing more than a ton of water per minute on smoldering rubble or large piles of rubbish from a safe distance is another use of the 2 1/2-inch line. Although many times a master stream device can accomplish the same objective with less physical effort on the part of the firefighters operating it, sometimes the flexibility afforded by a high-volume handline is required. At many fire operations, master stream devices and high-volume handlines are used simultaneously, and this often is the soundest approach in terms of its tactical benefit to the incident commander.

Standpipe System Operations

As I discussed in my article "Standpipe System Operations: Engine Company Basics" (Fire Engineering, February 1996), the many variables involved in using standpipe systems require that 2 1/2-inch hose be used. A 2 1/2-inch handline fitted with a 1 1/8- or 1 1/4-inch solid-stream nozzle tip can deliver a significant quantity of water at very low pressure. Pressure problems are common at standpipe operations, and the pressure available at upper-floor hose outlets may not be sufficient to overcome the high friction loss produced by smaller handlines at desired flows. The chapter "Standpipe Work at Fires" in The Fire Chief`s Handbook, Second Edition (The Reuben H. Donnelley Corporation, 1960) indicates that even with less than 50 psi pressure available at the hose outlet, a flow of about 220 gpm can be provided through three lengths (150 feet) of 2 1/2-inch hose equipped with a 1 1/8-inch solid-stream tip. The Handbook states on page 360 that "about 30 to 35 pounds nozzle pressure is enough for men to handle when working into a smoke-filled floor and will furnish a stream of sufficient strength and reach if properly applied." The fact that even at very low pressures 2 1/2-inch hose can easily deliver more than 200 gpm makes it the best choice for firefighting safety and effectiveness during standpipe system operations.

Regardless of when and where a 2 1/2-inch handline is used, reducing the tip pressure will produce a more manageable nozzle reaction force and facilitate better line movement and handling. At a flow of 260 gpm, the nozzle reaction produced by a 1 1/8-inch tip at 50 psi is about 95 pounds. By lowering the tip pressure to 40 psi, the nozzle reaction drops to about 76 pounds at a not-too-modest 236 gpm. Although by lowering tip pressures the upper end flows will not be delivered, streams significantly higher in volume than those produced by smaller-diameter lines are readily attained.

HANDLING 2 1/2-INCH HOSE

Many otherwise excellent texts and training guides on firefighting procedures depict 2 1/2-inch hose as an immobile handline reserved for use at lumberyard fires or other defensive operations. It is usually illustrated in a fixed position, with the hose formed into a loop and the nozzleman sitting atop the line at the point where the hose crosses over itself. Sometimes it is shown being held by three or four firefighters, often on opposite sides of the line, grasping the handles of the nozzle playpipe or supporting the hose on their shoulders using hose ropes or straps. In either case, movement of the 2 1/2-inch line is handicapped, and it can hardly be considered an effective handline for interior fire attack. With the right hose and nozzle and regular training, however, 2 1/2-inch hose can be developed into a highly mobile handline, well-suited to offensive and defensive firefighting.

Modern fire hose is exceptionally lightweight. Most outer jackets are made of a synthetic fiber weave, and couplings are constructed of aluminum alloy. Modern nozzles are also very lightweight and of aluminum-alloy construction. Some new solid- stream nozzle tips are made of highly durable plastic. Nozzles used with 2 1/2-inch hose are not limited to stacked-tip configurations and large playpipes with handles. FDNY has used "direct-connect" 2 1/2-inch nozzles for decades, never having adopted playpipes. Direct-connect nozzles feature a compact shutoff and a detachable nozzle tip. FDNY currently uses a 1 1/8-inch nozzle tip, but the 1 1/4-inch tip was used for many years and still is the standard tip size in Chicago and several other cities. Recently, FDNY has started a pilot program to evaluate pistol-grip shutoffs for 2 1/2-inch hose. While there are pros and cons to using pistol grips (which I have discussed in previous articles), I am in favor of pistol grips on 2 1/2-inch handlines to aid in resisting the high nozzle reaction force generated by a ton-per-minute fire stream. Even if your department prefers 2 1/2-inch nozzles with playpipes, modern playpipe assemblies are available in lightweight construction.

Effective use of the 2 1/2-inch handline requires thorough training so firefighters become familiar with its size, weight, and handling. A nozzle team assigned to operate a 2 1/2-inch line should stretch the line dry as far as safely practical. It is much easier to move an uncharged line than a charged one. Once the line is charged, it must be bled of air. While all handlines must be bled prior to advancing, 2 1/2-inch hose entrains more air than smaller lines. Thoroughly bleeding the line is of particular importance at operations involving automatic and nonautomatic dry standpipe systems. In addition to air being trapped within the 2 1/2-inch hose itself, large amounts of air from an improperly flushed standpipe riser will enter the line and must be bled off at the nozzle. A story was related to me about a nozzleman who failed to bleed the line properly at a fire involving a couch in a standpipe-equipped building. The air that was discharged through the nozzle quickly increased the size and intensity of the fire, which grew to involve the entire living room.

-Controlling and operating a 2 1/2-inch hand-line, while far from easy, can be facilitated by following these basic rules:

-The nozzleman must keep sufficient hose out in front to permit unhindered nozzle movement.

-The backup man should lean into the nozzleman to provide physical support in resisting the nozzle reaction.

-The backup man must keep the line low behind the nozzleman and as straight as possible.

-The backup man should "pin" the hose to the ground using his hands or knees, thus easing the task of resisting the reaction force without adversely affecting nozzle movement.

-When moving the line, shut down or gate down the nozzle to reduce the reaction-burden. Make sure the fire area ahead of the line has been cooled sufficiently before advancing.

-Attempting to stand while operating a 2 1/2-inch line is difficult at best. If a doorway, wall, or tree is nearby, lean against it and use it to help resist the nozzle reaction.

-It may be necessary to assign additional personnel to "lighten up" on the line and keep it moving. This is especially important during standpipe operations or when the line must make several bends and turns.

-If a 2 1/2-inch line is being used in a purely defensive mode and staffing levels are light, forming the line into a loop, as described earlier, is an acceptable technique.

It should be noted that many of these rules apply to any size handlines. In addition, due to the long stream reach produced by a solid-stream tip and 2 1/2-inch hose, geometry tells us that a small movement of the nozzle will result in the distribution of water over a rather wide arc some 60 or 70 feet away. This is important because rapid nozzle movements are not easily performed when 250 gpm or more is flowing.

BIG FIRE, BIG WATER

Most structure fires (probably around 90 percent or so) are quickly controlled by a single 1 1/2, 1 3/4, or 2-inch handline. It`s the other 10 percent, however, that necessitate fire departments` maintaining 2 1/2-inch handlines on their apparatus. Minimal staffing does not alter the fact that some fires require 2 1/2-inch handlines for expeditious control. When big fires occur, big water is needed; 2 1/2-inch hose is a time-tested fire attack tool for delivering high-volume flows with long reach and exceptional knockdown power. It remains a vital part of the municipal fire service arsenal.

FDNY standard operating procedures require the use of 2 1/2-inch hose for fires involving stores, factories, and other commercial occupancies. Nozzle teams should use the long reach and high volume of the 2 1/2-inch stream to best advantage when attacking fires in these and similar occupancies. Be cautious when advancing the line at commercial building fires. It is possible that what appears to be a first-floor fire actually originated in the cellar or subcellar. (Photo by Bob Pressler.)

When an advanced fire is encountered, a 2 1/2-inch handline is needed for rapid control. Unlike most portable master stream devices, 2 1/2-inch hose can be deployed quickly and is highly mobile, allowing its operation from positions that are inaccessible to master stream devices. This is particularly important when life safety is a factor or when the potential for autoexposure or fire extension to nearby buildings exists. Large, uncompartmented areas (supermarkets, department stores, manufacturing occupancies, service garages, and so on) require the use of 2 1/2-inch hose to best ensure firefighter safety. High-heat conditions and a large volume of fire demand the 250 to 320 gpm flow possible from a 2 1/2-inch handline. A solid-stream tip (1 1/8 or 1 1/4-inch) will provide exceptional reach while minimizing premature water vaporization. A 2 1/2-inch handline is ideal for defensive firefighting operations. Its long-reaching, high-volume stream permits firefighters to operate outside the collapse zone, but it is more flexible than a portable master stream device. Oftentimes, 2 1/2-inch handlines and master stream devices are used together to control large fires and keep exposure buildings cool. Standpipe system operations require 2 1/2-inch hose and solid-stream nozzles because they can deliver flows of more than 200 gpm at very low pressures. The friction loss per 50-foot length of 2 1/2-inch hose while flowing 260 gpm is only about six to eight psi.

A 2 1/2-inch handline often proves too difficult to bend and maneuver within the confines of residential buildings and other small occupancies. After a quick knockdown from the outside, the 2 1/2-inch line can be reduced to a 1 3/4- or 2-inch hose by simply unscrewing the nozzle tip and connecting the smaller hose to the nozzle shutoff. It is important to prevent the shutoff from being inadvertently closed, which could result in burn injuries to the nozzle team. It is easily secured in the open position using a short length of rope. (Photo by author.)

Note how the backup man is "pinning" the 2 1/2-inch hose to the ground using his hands and knees. This allows him to resist the nozzle reaction without undue stress and permits the nozzleman to freely move the nozzle. The nozzleman must strive to keep the nozzle in front of and away from his body to permit effective movement of the stream. (Photo by Matt Daly.)

Modern 2 1/2-inch nozzles are lightweight and very compact. These so-called "direct-connect" nozzles often feature pistol grips. Attaching this type of nozzle to lightweight 2 1/2-inch hose makes a highly effective hose/nozzle combination that is well-suited to offensive firefighting. If your department prefers 2 1/2-inch nozzles with playpipes and handles, modern types are made of lightweight aluminum alloy and are much easier to carry and manipulate than heavy, brass ones. This 2 1/2-inch handline is fitted with a lightweight nozzle that features three stacked tips to provide a range of high-volume flows. (Photos by author.)

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STRETCHING AND ADVANCING HANDLINES, PART 1

BY ANDREW A. FREDERICKS

Quickly stretching and advancing a handline is the most fundamental and important firefighting function an engine company performs. This series of two articles will discuss the proper stretching and advancing of handlines to control and extinguish structure fires-fires where lives are most often at stake. Part 1 will examine various considerations in stretching handlines, and Part 2 will cover techniques to ensure a safe and efficient advance to the seat of the fire.

INDISPUTABLE TRUTHS

Although tactical considerations governing the selection and placement of handlines based on needed fire flow and fire control objectives will not be addressed here, three indisputable firefighting truths concerning handlines bear mentioning. First, it should be the rare situation indeed that a second handline is stretched before the first line has been stretched, charged, and started its advance on the seat of the fire. The fire control efforts of the first handline save more lives at structure fires than any other firefighting action. Placing the first handline in service must be the primary objective of first alarm engine companies.

Second, in almost every case, the first handline should be stretched through the front entrance to best ensure prompt fire control and the saving of lives. The front entrance is usually the most accessible and easiest to reach; it leads directly to the main hall and stairs--usually the primary means of egress for building occupants--and permits the first handline to be placed in service quickly to protect firefighters performing search operations on the fire floor and the floor(s) above.

Third, as near as possible, the ideal amount of hose necessary to reach the fire should be stretched. When an insufficient amount of hose is stretched (a so-called "short" stretch), rapid fire control will not be achieved, and a lot of screaming will take place on the fire floor. If too much hose is stretched, excessive kinks and high friction loss become problems. The fear (bordering on paranoia) of not stretching enough hose has resulted in stretches with up to six or seven extra lengths. Stretching the correct amount of hose for a given fire situation requires knowledge of various building types and an accurate estimate of the distance between the engine apparatus and the seat of the fire.

BASIC RULES OF STRETCHING HOSE

The following basic rules apply anytime a handline is stretched:

1. You must know the exact location of the fire before you can correctly estimate a handline stretch. The importance of this rule cannot be overstated. A reported fire on the third floor does not necessarily mean that the fire is on that floor. The fire may turn out

to be on the fifth floor, and removing only enough hose to reach the third floor would cause a significant delay in applying water on the fire. In addition to facilitating a more accurate estimate of the hose required, waiting until the location of the fire has been confirmed will help to avoid stretching the line to the wrong place. Handlines have been stretched to the wrong floor, into the wrong wing of a building, and even into the wrong building altogether.

2. Estimating the amount of hose required to reach a fire is a two-step process. The first step is to determine the amount of hose needed within the fire building. This amount of hose is usually consistent for a given family or group of buildings, simplifying the hose estimate. The second step is to determine how much hose is required between the engine apparatus and the entrance door to the fire building. This will vary according to how far the building is set back from the street; the position of the engine apparatus in relation to the building entrance (often a factor of the type of water supply procedure employed); and landscaping, fencing, or other obstructions that might increase the amount of hose required. The use of preconnected handlines has somewhat eroded firefighters` abilities to estimate how much hose will be needed. But even when preconnected lines are employed, some hose estimation is required, especially when preconnected handlines of various lengths are carried on the same apparatus.

3. Pre-incident planning is essential. For large-area buildings and garden-apartment complexes, stretching dry lines during training exercises or pre-incident planning activities will help eliminate problems when a fire does occur. Long handlines may be required, and engine apparatus should be equipped with hose loads that allow for a rapid and efficient stretch even when the fire area is beyond the reach of the longest preconnected line.

ESTIMATING THE STRETCH

As mentioned in Rule #2 above, many types of buildings (particularly residential buildings) allow for fairly accurate estimates of the amount of hose required. Most rules for estimating hose are based on a building`s size and its stair configuration. Each City of New York (NY) Fire Depart-ment (FDNY) engine company assigns an experienced firefighter to "control" the handline stretch. The "control firefighter" is responsible for estimating the amount of hose needed to reach the fire and ensuring that it is properly removed from the hosebed. When I am assigned this position, I use several basic formulas to assist in determining the amount of hose required. FDNY does not use preconnected handlines, due to the tremendous variation in hose stretches faced by firefighters in New York City. Handline stretches in my area of the Bronx can vary from about three lengths (150 feet) up to 14 lengths (700 feet) or more, making accurate hose estimation vital.

The first formula concerns private dwellings. Most private dwellings (up to three stories) can be covered with between one and three lengths of hose, depending on the dwelling`s size. It is a good idea to stretch enough hose to cover the entire dwelling, since the line may have to be repositioned to cut off a rapidly extending fire. The amount of hose required to reach the entrance door from the street may be two or three lengths in suburban areas, but often a single length will suffice. Fires in two-story garden apartment buildings are effectively reached by two lengths; three-story garden apartments require a third length. It may require a significant amount of hose to reach the entrance of the garden apartment building itself. This issue is addressed later.

Another formula can be used for small multiple dwellings (buildings with a front-age of 35 feet or less and a depth of between 50 and 75 feet). For these small buildings, simply use the floor number of the fire floor to determine the amount of hose required. For example, a fire on the fourth floor would require four lengths of hose within the building to reach a rear room in the fire apartment. This accounts for one length of hose between the first and second floors, a second length between the second and third floors, a third length between the third and fourth floors, and a length for the fire floor. (Maintaining at least one length on the fire floor is another good practice. Larger buildings may require up to two lengths or more.) Since the distance between the front entrance and stairs is short and the stairs are usually of a small, U-return type, this formula works very effectively. Lengths of hose are added based on how far the engine is from the building entrance.

In the case of larger multiple dwellings (buildings with frontages from about 36 feet up to 100 feet and depths up to 100 feet or so), start with the floor number of the fire apartment and immediately add one length. More lengths may be required as follows: The distance between the entrance door and stairs may require at least one full length; a very large building will warrant a second length on the fire floor. For a fire on the sixth floor of a large multiple dwelling, my initial hose estimate is six lengths, plus one, for a total of seven lengths. If it turns out that the distance between the entrance door and stairs is about one length, I will add this to the estimate, for a total of eight lengths. Many of these buildings have large apartments, straight-run stairs, long hallways, and large lobbies. These features demand a hose estimate formula more generous than the one used for smaller multiple dwellings. In the example above, five lengths are needed to reach from the base of the stairs to the sixth floor; one length is needed between the entrance door and the stairway itself; and two lengths are available on the fire floor due to the long hallways and large apartments. Additional lengths will be needed between the fire building entrance and the engine apparatus.

HOSE STRETCH VARIATIONS

Occasionally, a stair configuration may require adjustments to the basic hose estimation formulas. One such configuration is that in which the stairs wrap around an elevator shaft. Although not a common arrangement, it dramatically increases the difficulty of the stretch and requires that additional lengths be figured into the hose estimate. On the other hand, sometimes fewer lengths of hose are needed to reach a given fire area. Some stairways contain a well-hole, a vertical opening within the center of the stairway that often permits a single 50-foot length of hose to reach from the first to the fifth floor. The presence of a well-hole must be made known as soon as possible so the hose estimate can be adjusted accordingly. Effective use of a well-hole can reduce substantially the number of lengths required. This in turn increases the speed with which a handline can be placed in service and significantly decreases friction loss.

Although many commercial buildings require thorough pre-incident planning to determine the amount of hose necessary to reach specific areas, typical "main street" businesses--those located on the first floor of multiple dwellings or in one- and two-story taxpayer buildings--can usually be covered by one or two lengths of hose. Most of these buildings are between 50 and 100 feet deep, and entrances are readily accessible on the sidewalk. An additional length should be added for a cellar fire, since many bends and turns may have to be made, or should an alternate entrance have to be used for the line advance.

When stretching a second handline at a structure fire, it is good practice to make the second line longer than the first by one length. Although the primary purpose of the second handline is to ensure the safety of the nozzle team assigned to the first line, in multistory buildings the second line is often directed to cover areas above the main body of fire. Operations on the floor above the fire may be ordered to protect searching firefighters or to control fire extension. Even in one-story structures, the second line may be directed into adjoining areas, and additional hose may be required. Im-mediately adding another length in anticipation of operating above or adjacent to the main body of fire will save time and provide for a smoother, more professional operation.

FDNY standard operating procedures require that anytime a third line is needed, it be stretched via the outside of the building. This is done to reduce the difficulties created when three lines are stretched via the interior stairs. Three charged lines on a narrow staircase can make moving up and down extremely hazardous and advancing the lines difficult, since they often become entangled. A quick and easy way to stretch a line on the outside of a building is to use a utility rope. The rope can be deployed from a stairway window, an apartment window, a fire escape balcony, or the building`s roof. FDNY uses a 75-foot-long 3/8-inch nylon rope, which is stored in a 1 1/2-gallon empty plastic bleach bottle with a hole cut near the top. Many companies attach snap hooks to each end of the rope. The nozzle firefighter and officer ascend to the point at which the rope will be deployed while the balance of the engine company stretches the handline to the "drop point." Once the rope is dropped, it is attached to the hose using either a clove hitch and binder, a simple hitch, or the snap hook, which is wrapped around the hose behind the nozzle and then hooked onto the rope. Utility rope stretches also come in handy at fires in large buildings with complex layouts and when the stairs wrap around an elevator shaft, as discussed above.

One more point: While it may be necessary to use an aerial ladder to stretch a handline, do not allow a charged line to lie on the ladder. Instead, let the line run vertically up the side of the building and properly secure it with a hose strap. This will reduce the amount of hose needed in the stretch and free the aerial ladder for other critical duties. Aerial ladders are purchased by fire departments for the following reasons (listed in ascending order of importance): (4) to provide elevated master streams, (3) to provide access to the fire building for topside ventilation and VES (vent-enter-search) operations, (2) to rescue or remove civilian victims, and (1) to rescue firefighters trapped on the upper floors. If the aerial is tied up with a handline, this defeats its primary purpose, and firefighters lives may be jeopardized. Tom Brennan has made this point more than once in his Random Thoughts column, and I feel it is important enough to mention again.

In the absence of a utility rope, a six- or eight-foot hook can be used to stretch a handline to the upper floors via a fire escape. Place the bale or handle of the nozzle shutoff on the hook, which is held in an inverted position and passed hand-over-hand to firefighters stationed on each fire escape balcony between the ground and the point at which the line enters the building (most often the floor below the fire). For extra security, the nozzle can be lashed to the hook with a hose strap or a short length of rope. This technique is a modification of a hose-stretching method used many years ago that used a special "fire escape hook."

WHEN PRECONNECTED LINES FALL SHORT

How do fire departments successfully handle structure fires that cannot be reached by preconnected lines? Several methods are available to quickly ensure placement of the first handline (as well as a backup line), even when fire areas are a considerable distance from the engine apparatus. One method is to use a "bulk," "dead load," or "static" hosebed--containing hose that is not preconnected. Carrying hose in this fashion permits the effective use of a "reverse lay" or "backstretch" and allows rapid deployment of a long handline.

Static hosebeds may contain up to 16 lengths of line and are used very successfully by many fire departments, including FDNY and Los Angeles City, California. In FDNY, each engine is equipped with two 1 3/4-inch and one 2 1/2-inch hosebeds. The 1 3/4-inch beds contain no more than six lengths of 1 3/4-inch hose "filled out" with 2 1/2-inch hose, to reduce friction loss when a long stretch is required. Los Angeles City engines are equipped with three transverse hosebeds (sometimes called "crosslays"), each containing a handline loaded in bulk fashion. After the necessary amount of hose is removed, the line is broken and attached to one of three discharge outlets located below the transverse hose compartments.

Another method of overcoming the limitations posed by preconnected lines is to combine the features of a static hosebed with a preconnected hose load. Part of the hose loaded in a hose compartment is preconnected. Additional hose is carried in bulk fashion below the preconnected line or in an adjacent compartment. If more line is needed, it is added to the preconnected line near the engine apparatus. A problem posed by this method is that most crosslay hosebeds feature a discharge outlet on a chicksan swivel. The swivel is often difficult to reach due to the height or width of the crosslay hose compartment. A simple solution is to connect a five- to 10-foot length of hose to the swivel outlet. This makes breaking the line to add more hose an easy process and eliminates any delays in getting water on the fire. The same solution can be used for preconnected lines loaded at the rear of the apparatus. Many older engines are fitted with discharge outlets at the front of the hosebed, not readily accessible from the rear step. By using a 10- or 15-foot length of hose, the handline can be quickly broken and additional lengths inserted as needed.

Still another method is to use a static hose load consisting of 2 1/2-inch or three-inch hose with a manifold (usually a gated wye or "water thief" appliance) attached. Anywhere from two to four lengths of 1 3/4- or two-inch leader line are preconnected to the manifold and bundled as a "skid load" for efficient transport. The bundled hose may be held together by old seat belts, nylon webbing, or sections of inner tube. Once the manifold is in position, the leader line is unbundled, charged, and advanced into the fire area. In the case of multistory buildings, the manifold may be deployed in the lobby or on the floor below the fire, depending on the location of the fire in the building. At fires involving garden apartments or private dwellings set well back from the street, the manifold is usually brought to a point just outside the entrance door. The leader line is then flaked out and charged. A second line can be quickly attached to the manifold--and perhaps even a third and fourth line--depending on the size of hose supplying the manifold and the type of manifold in use. Large manifolds with up to six 2 1/2-inch outlets are available for use with four- and five-inch hose.

Once a manifold has been placed in service and the first line is charged and advancing on the fire, where is the hose that is to be used for subsequent handlines obtained? Some departments merely disconnect preconnected lines from the apparatus and drag or carry them as a shoulder load to the manifold. Other departments use additional bundled hose loads. Still others carry the hose in a soft-sided bag or case. As I mentioned in "The 2 1/2-Inch Handline" (Fire Engineering, December 1996, pp. 36-49), whenever a leader line is attached to a nozzle shutoff or manifold, the shutoff or manifold should be secured in the open position to ensure the safety of the nozzle team.

STRETCHING THE HANDLINE

Once the correct amount of hose has been removed from the apparatus, it must be brought to the point of operation. I will not begin to describe the many different hose loads in use, but I must mention some key considerations in loading hose that will facilitate a rapid and efficient stretch. One is to load the hose such that the firefighter assigned to the nozzle can easily remove the nozzle and at least one length of hose. The nozzle firefighter is responsible for the length of hose that is advanced into the fire area--the so-called "working length." It is very poor practice to simply grab the nozzle and run, trailing hose behind. This hose inevitably gets caught on car tires, tailpipes, shrubbery, fences, door jambs, and so on. If the nozzle firefighter does not stretch sufficient hose to cover the anticipated fire area, he has failed in his mission. Likewise, avoid "pulling and piling." Pulling hose off and creating a pile near the apparatus causes knots in the line and greatly increases the potential for kinks once it is charged. In addition, load each preconnected handline so that the entire amount of hose is easily removed or "cleared" from the apparatus, thereby reducing the possibility of charging the line with hose still remaining in the bed.

Another important consideration is to stretch the line uncharged or dry as far as safely practicable. It is much easier and more efficient to stretch a dry line than to advance a line that has been charged prematurely. The point at which the line gets charged varies with the size and type of building involved. Normally, at private dwellings, the line is charged in the front yard or driveway or on the floor below the fire, if cramped quarters do not make this impracticable. If the line is flaked out in the yard or driveway, it is desirable to form a series of "S"-shaped curves to reduce the potential for kinks. For a second- or third-floor fire, the first 20 to 30 feet of line should be kept straight to permit a quick advance up the stairs.

At multiple dwellings, the line is usually stretched to the public hallway and charged just outside the entrance to the fire apartment. The safety of this tactic hinges on control of the fire apartment door. That is why it is so important to preserve a door`s integrity (minimize distortion so it can still be closed) when forcing it open and to maintain control of it by placing a piece of rope or a hose strap over the doorknob. If fire conditions deteriorate severely before the handline is ready or if a loss of water occurs, you can pull the door shut quickly by grabbing hold of the rope or hose strap. If a size-up of the door indicates the fire is immediately behind the door (blistering or melting paint, door or knob hot to the touch, door or knob glowing red), do not under any circumstances force it open until the line has been charged and bled. Many times the fire apartment door is left open by a fleeing occupant, allowing fire to extend into the public hall. Sometimes the fire has burned through a wooden door or transom, making the public hallway untenable. While ladder company personnel should attempt to close an open apartment door or seal the opening with a door forcibly obtained from an apartment elsewhere in the building, the handline will have to be charged on the floor below the fire and advanced up the stairs. This will require more effort, but it is the only safe course of action. It may also be more efficient to charge the line on the floor below or on the stairs leading up to the fire floor in multiple dwellings with narrow hallways and small landings.

If the fire apartment door is controlled and there is no immediate danger of extension into the public hall, the line should be flaked out on the fire floor. Make every effort to reduce the potential for kinks and to ensure an unhindered advance to the seat of the fire. This may require flaking some of the line out on the stairs leading to the floor above the fire (or the roof bulkhead in the case of a top-floor fire). Two benefits provided by this tactic include less line on the landing, which may be small and crowded, and the assistance gained from gravity feeding the line down the stairs and into the fire apartment. This tactic can also be very dangerous if control of the fire apartment door is lost while the firefighter flaking out the line is still on the stairs above. The firefighter assigned to flake out the line on the stairs (most often the backup firefighter) should ascend only as far as necessary while staying low and against the wall, not the balustrade. His SCBA face piece must be in place, and communication with the forcible entry team is essential. Another tactic is to force the door to an adjoining apartment or, preferably, an apartment opposite the fire apartment and flake the line out inside. Although this may be safer than exposing a firefighter on the stairs above the fire, will the forcible entry tools necessary to force open one or more other doors be available? Will opening the door to another apartment cause the fire to extend or endanger occupant lives due to contamination by heat and smoke? In all cases, these various factors must be carefully (albeit quickly) weighed and a course of action chosen.

MODERN APPARATUS DESIGN

Apparatus design also affects the task of stretching handlines. Engine apparatus continue to get longer, wider, and higher. Many hosebeds are well above the head height of the average firefighter--even when standing on the rear step. Crosslay hosebeds are also very high and are often a chore to reach. This has impacted fireground safety and efficiency by increasing the difficulty in removing hose and stretching handlines. It has also increased the potential for muscle-strain injuries to personnel and the time required to get water on the fire. The height of modern hosebeds can be attributed to both an increased demand for compartment space and today`s average booster tank capacity. Even in urban and suburban areas with adequate water supply systems and engines equipped with large-diameter hose, 750- and 1,000-gallon booster tanks are common. Why? The main reason is staffing. Criminally low staffing levels have forced fire departments to alter their tactics. Increasingly, fire attack operations are initiated with booster water because only two or three personnel arrive with the first engine. In anticipation of a delay in establishing a continuous water supply, larger booster tanks are specified to provide more operational time and a wider cushion against running out of water. Hose loads should be designed as best as possible to overcome the limitations posed by modern apparatus and to recognize the size, strength, and physical abilities of the average firefighter.

OTHER CONSIDERATIONS

Individual fire departments must evaluate their response areas, building types, staffing levels, and hosebed capacities to determine what hose loads will work best for them. The actual mechanics of stretching handlines must be practiced on a regular basis, especially the more difficult and uncommon stretches. For example, a department that routinely fights fires in small, private homes using preconnected handlines must practice stretching hose from a static bed to reach a fire on the upper floors of the few multiple dwellings it protects. Stretching handlines via a wellhole is another tactic that requires practice and discipline on the part of the firefighters involved. Deploying manifolds and leader lines is yet another important tactic requiring regular drills to ensure proficiency. Consult some of the many excellent firefighter training guides for specific information on various hose loads and methods of stretching lines. Ideas and suggestions can also be obtained by visiting neighboring fire departments to see firsthand the types of hose loads in use and how they address operational problems. The chapter "Handling Hose and Nozzles" in Fire Stream Management Handbook by David P. Fornell (Fire Engineering Books, 1991) is an excellent source of information on various hose loads and hosebed configurations used by fire departments around the country.

One more issue must be addressed when discussing handlines--accurate pump discharge pressure (PDP). Most departments label individual gauges or discharge valve handles with preset pressures for their preconnected handlines. This is an effective and widely used system. Complications may arise, however, when a static hose load or manifold and leader line are stretched. In the latter case, if the manifold itself is preconnected and the leader lines are all of the same diameter and length, preset pressures can still be used. If the manifold is not preconnected and its length varies depending on the distance between the engine apparatus and the point of operation, the chauffeur or pump operator must be informed as to how much hose of each size has been stretched so he can calculate the correct PDP. The same is true if hose is stretched from a static bed. In the case of multistory buildings, the chauffeur must also be told what floor the fire is on, which may not be evident at night or if the fire is in the rear of the building or in a shaft. As handlines grow longer, it is also wise to increase the diameter of the hose to keep friction loss to a minimum. A rule of thumb is to use no more than four lengths of 1 1/2-inch hose, six lengths of 1 3/4-inch hose, or eight lengths of two-inch hose. Using fewer lengths, of course, is better, especially if 100-psi fog nozzles are used as opposed to low-pressure fog nozzles or smooth-bore tips. Using a larger-diameter hose (2 1/2-inch most often) to "fill out" a long stretch is another widely adopted solution. Reducing the PDP minimizes the potential for burst lengths of hose.

As a chauffeur, I must emphasize one more point when stretching hose from a static bed: Once sufficient hose has been removed and the line is broken, let the chauffeur decide to which discharge outlet it should be attached. I prefer to attach the first and second handlines to the pump panel where I can observe them and label them with a grease pencil. Face-to-face communication is essential, as illustrated by the following story: A veteran chauffeur in Brooklyn was suddenly contacted by an officer in charge of a handline desperately asking him to charge the line. The chauffeur assumed at first that the officer was mistaken and was actually trying to contact another chauffeur. Just to be on the safe side, however, he walked around to the opposite side of his rig to investigate. Sure enough, a dry handline was attached to a discharge outlet, and it proved to be the handline in question. The firefighter who had broken this line and connected it to the rig never informed the chauffeur he had done so. Not only didn`t the chauffeur know how much hose had been stretched, he didn`t even know he was responsible for supplying another handline. Communication on the fireground, particularly between the chauffeur and the nozzle team(s) he is supplying, is vital. Take a few seconds to talk, and you may save yourself a lot of heartache later.

PREPARING FOR THE ADVANCE

Even after a long and difficult hose stretch, the real work of the engine company has yet to begin. This is where experience and training really pay dividends. As the late senior member of Engine Company 48 in the Bronx used to say, "Never run to the rig when turning out for an alarm; if you run to the rig, you`ll run at the fire, and running leads to shouting and the job won`t get done." Experienced firefighters know how to pace themselves--both physically and mentally; this conserves energy, prevents needless injuries, and enables them to maintain a focus on the task at hand without losing sight of the big picture. Advancing a handline at a tough fire requires discipline, concentration, and some intangible factors--courage, mostly--to see the job through. The many considerations in advancing handlines will be covered in Part 2. Emphasis will be on the first line, since it is the most critical.

Fire Engineering
April 1997

STRETCHING AND ADVANCING HANDLINES, PART 2

BY ANDREW A. FREDERICKS

Part 1 (March 1997) covered stretching handlines, including estimating the amount of hose needed for specific types of buildings and hose loading techniques to effect prompt handline placement under a variety of operating conditions. Part 2 describes procedures to help ensure a safe and efficient advance to the seat of the fire, with specific attention given to the first line, as it is responsible for saving most lives at structure fires.

THE NOZZLE TEAM

In many cases, engine company staffing provides for only two firefighters (or one firefighter and an officer) to stretch and advance the first handline. Where most firefighting operations are performed in private dwellings using preconnected lines, two firefighters may be sufficient. In areas where longer, more difficult stretches are necessary, three or more firefighters will be needed. An incident commander should never hesitate to team together two, three, or even four engine companies to ensure prompt placement and operation of the first handline at a structure fire. In addition to the required number of firefighters, an officer should be assigned to direct the advance of the line. The benefits to be derived from having a supervising officer are described more fully below.

The first two firefighters on a handline (as well as the officer, if present) are commonly referred to as the "nozzle team." One firefighter is assigned to operate the nozzle and the other (called the "backup" firefighter) helps resist the nozzle reaction so the nozzle firefighter can freely manipulate the nozzle. If a third firefighter is available, he is assigned the "door" position. Once the handline begins its attack on the fire, the "door" firefighter facilitates a smooth and rapid advance by feeding hose to the nozzle team. In the City of New York (NY) Fire Department (FDNY), some engine companies have a fourth firefighter to assist in stretching and advancing the handline. This firefighter is assigned the "control" position, described in Part 1. In those engine companies without a separate and distinct "control" position, the door firefighter assumes responsibility for controlling the stretch. Once the line is charged, he moves into position at the door to the fire area and feeds hose to the nozzle team.

Let`s examine the specific responsibilities given to each firefighter during the handline advance, beginning with the engine company officer.

THE ENGINE COMPANY OFFICER

Many engine companies include an officer in their staffing levels, but all too often he is a "working" officer, forced to assist with both stretching and advancing the handline. In some fire departments, the engine company officer is actually the nozzleman or backup man. This detracts from his ability to observe conditions, communicate with the IC, and monitor the safety of the nozzle team. In addition to these important functions, what other advantages does a supervising officer provide?

At private-dwelling fires, the officer can often make a quick perimeter survey as the handline is being stretched. This will assist in determining the location of the fire and provide information on fire extension and rescue problems. An interior survey also should be attempted, including conducting a quick primary search in the immediate fire area and closing any doors that will help retard fire spread. This is especially important when no ladder company is on the scene or it is understaffed. At multiple-dwelling fires, the officer can assist in the hose estimate and should immediately announce the presence of a wellhole and report on any unusual conditions that will affect the handline stretch.

When there is no ladder company present, the officer should confirm the floor and number of the fire apartment and attempt to gain entry to locate the fire and search for any trapped occupants. If heat and fire conditions preclude a search, a glance below the smoke may prove helpful.

If a ladder company arrives along with the engine, an effective technique for the engine company officer is to drop down to the apartment below the fire apartment and attempt to gain entry. This will provide the officer with important information concerning the layout of the fire apartment, which can then be relayed to the nozzle team. If the fire apartment is in the rear of the building, there may be no indication of the fire`s location from the street.

To help pinpoint the fire room(s), the officer should look out any rear and side windows of the apartment below for signs of smoke and flame issuing from the fire apartment. Once the fire`s location is determined--either visually or from radio reports given by ladder company personnel searching the fire apartment--the officer should count the number of doors, the required number of left- and right-hand turns, and the approximate distance between the entrance door and the seat of the fire. On his return to the fire floor, it may also prove valuable to look out the stairway window at the half landing to obtain one more view of the fire apartment from the exterior. The same techniques can be used for second- and third-floor fires in garden apartment buildings. Even for a first-floor fire, the adjacent apartment is usually a mirror image of the fire apartment, and much information can be obtained by taking a quick look. Of course, no matter what the fire situation, information gathered from occupants, neighbors, and early arriving police officers may prove extremely valuable.

THE NOZZLE FIREFIGHTER

When possible, the firefighter assigned to the nozzle should be both aggressive and experienced. In the absence of an officer, the nozzleman establishes the pace of the handline advance and makes many decisions on which the outcome of the entire firefighting operation hinges. He chooses when to open and close the nozzle and where to direct the stream to confine and extinguish the fire as quickly as possible. Without an officer present, the nozzleman must be equipped with a portable radio to call for water, to report information on the progress of the fire attack operation, and to request help when necessary.

The nozzleman must maintain control of the nozzle at all times. While waiting for the line to be charged, he should kneel on the hose immediately behind the nozzle and ensure it does not get kicked by a passing firefighter. He is also responsible for bleeding trapped air from the line prior to the advance.

Some nozzlemen prefer to crack the nozzle open as they await water. This provides immediate indication that the line is being charged and allows the air to bleed off as the hose fills with water. Others simply wait until the line stiffens and then bleed off the trapped air. In addition to exhausting trapped air, cracking open the nozzle provides the nozzleman with assurance that the engine apparatus is in pump gear.

Occasionally, an inexperienced chauffeur may forget to place the rig in "pumps." Due to the "flow through" nature of centrifugal pumps, hydrant pressure will permit the handline to fill with water, but the pressure received at the nozzle may be inadequate to produce an effective fire stream. NEVER enter the fire area or suspected fire area with an uncharged handline.

Use straight or solid streams for the fire attack--as they are much less disruptive to the thermal balance than fog streams. As a result, they help maintain better visibility, produce less unwanted steam, and are less likely to "push" fire. They also have long reach, which is necessary when several rooms are involved or you encounter a long hallway.

If using a fog nozzle, the nozzleman must ensure that it is in straight-stream position. As the nozzleman holds the nozzle, straight-stream position requires that he rotate the pattern adjustment ring clockwise. It is a good idea to keep fog nozzles in straight-stream position at all times, but the nozzleman should still check while waiting for water.

As a general rule, do not open the nozzle on smoke. The nozzleman should wait until he encounters fire and direct the stream toward the ceiling while whipping the nozzle in a clockwise or side-to-side motion.

After the fire begins to "darken down," the nozzleman can lower the angle of the nozzle and soak the smoldering solid fuels with water. If the fire is relatively small to begin with, deflecting the stream is not necessary. Once a fire has started to roll across the underside of the ceiling, he should direct the stream at an upward angle to allow droplets of water to rebound off the ceiling and upper walls, penetrate the thermal column of the fire, and cool the solid fuel materials below their vaporization temperatures. This will cause the flame front at the ceiling to diminish and permit a closer approach to the seat of the fire. (For more information on proper direct fire attack techniques and the use of solid-stream nozzles, see my article "Return of the Solid Stream," Fire Engineering, September, 1995, pp. 44-56.)

It is also very important for the nozzleman to sweep the floor periodically with the stream as the team advances. This pushes aside and/or cools burning embers, scalding water, and molten plastics. Even while members are wearing bunker pants, knee burns are still possible. The protective layers of the bunker gear are stretched tight over the joint when kneeling, thus eliminating much of their insulating qualities. Sweeping the floor also "sounds" the floor to provide indication that a hole or other opening lies ahead. Still one more important reason for sweeping the floor is to push aside glass shards, nails, and hypodermic needles. Bunker pants will do little to prevent penetration by a needle positioned at just the right angle. Use extreme caution when advancing over carpeting, as "sharps" may be stuck in the pile at crazy angles and may not dislodge when you sweep the floor. It may be safest to "duck walk."

I stated above that in most cases you should not open the nozzle on smoke. Recently, many veteran firefighters and officers have indicated that it may be necessary to rethink this approach. The fire environment has grown more dangerous and less predictable from the use of energy-efficient windows (not to be confused with simple, double-glazed windows), membrane roofs, and fuel materials that produce increasingly large quantities of dark flammable smoke. High heat conditions that force the nozzle team down to floor level with no visible fire may necessitate that the nozzle be opened on smoke, at least momentarily, to avoid burns from imminent rollover and flashover. I recently had such an experience with my local volunteer fire company at a cellar fire in an old, wood-frame, converted dwelling.

We advanced a handline down one of two interior stairways leading to the cellar. Initially, heat conditions were very tolerable at the top of the stairs, so a mad dash to the bottom was not necessary. A tenant insisted that the fire was "to the left" once we reached the bottom of the stairs. So at the bottom of the stairs, we made a left turn and advanced a little bit, but no fire was readily visible. It turns out we were not in the fire room but in a large utility room connected to the fire room by a doorway. The doorway itself was in the far corner of the room located behind two oversize water heaters. Unfortunately, almost as soon as our advance began, so did our problems. Three firefighters, including the nozzleman and me, stumbled into sump pits located around the boiler. A water pipe burst, spraying us with hot water; wires and plastic conduit dropped from the ceiling, producing an entanglement hazard; and all the while, heat conditions continued to intensify without any sign of fire rolling across the ceiling. Stone foundation walls, which radiated the heat in all directions, and a lack of available ventilation openings exacerbated our problems. Not knowing if fire was wrapping around behind us made me a bit leery of moving forward. After a firefighter descending the stairs said the venting smoke was now very hot, a decision was made to open the nozzle, even though no fire was visible. The nozzle was opened briefly and heat conditions did improve slightly, but I was still fearful of the worst. With our handlights shut off, we could finally see a glimpse of fire at ceiling level and quickly knocked it down. A handline had been stretched down the other stairway, and we soon heard the sound of its stream from our position in the utility room. Shortly thereafter, the doorway was discovered behind the water heaters. Opposing streams were never an issue, and fire venting up the other stairway made for a difficult push but also left no doubt as to the fire`s location.

THE BACKUP FIREFIGHTER

Although lacking the glamour associated with the nozzle position, the backup firefighter plays a key role in handline advance. He must absorb as much of the nozzle reaction burden as possible. The nozzleman and backup man must work in unison, giving the appearance of a well-oiled machine. During most fire attack operations, the nozzleman will be directing the stream toward the ceiling. In this case, the backup man must maintain the line low behind the nozzleman and as straight as possible. If the nozzleman lowers the nozzle to sweep the floor, to hit a burning mattress, or to direct the stream down a cellar stairway, the backup man must elevate the line behind the nozzleman. If the nozzleman directs the stream to the left, the backup man must move the line to the right. Conversely, if the nozzleman swings the nozzle to the right, the backup man must move his part of the line to the left. When no officer is present, the backup man should constantly observe conditions. He becomes the "eyes" of the nozzle team, alert to such dangers as fire rolling overhead, fire wrapping around from behind, or side rooms involved in fire.

The backup man should be in physical contact with the nozzleman. If the nozzle firefighter is relatively inexperienced, a senior backup man can help talk him through the fire, providing encouragement as well as physical support. When the advance must be made by only two people, the backup firefighter will have to move between his position immediately behind the nozzleman and a point several feet behind the operating nozzle to pull hose around corners and keep the line moving. If the officer is the second person on the line, he may be forced to break off on forays to vent and search, leaving the nozzleman to resist the nozzle reaction alone. This fact speaks for the value of low-pressure fog nozzles or solid-stream tips, which produce less reaction force than 100-psi fog nozzles.

THE DOOR FIREFIGHTER

The presence of a third firefighter during handline advance increases efficiency immeasurably. Due to smoke and physical barriers such as walls, the doorman will seldom be able to observe the nozzle team as it is advancing. To permit an unhindered advance without pushing the nozzle team, use the "bow" technique. This requires the doorman to feed sufficient hose toward the nozzle team until he creates a bow in the line. This bow represents slack that the nozzle team can pull trim without undue effort as they advance. As the bow straightens out, the doorman simply feeds more line until the bow is restored. If the team must make many bends and turns, the doorman might consider making a large bow behind him before he moves up to feed hose around the next corner.

When staffing levels are light, an alternative to the bow method is to create a loop in the line and roll the loop of hose into position behind the nozzle team. This provides hose to keep the advance moving when a door firefighter is not available. Obviously, a fourth firefighter on the line will increase the speed and efficiency of the advance still further. He should be initially positioned on the half landing below the fire floor in multiple dwellings and outside on the front steps or porch in private dwellings.

FINAL PREPARATIONS

After a difficult stretch, the opportunity to quickly regroup and catch your breath while waiting for the line to be charged can go a long way in reducing stress. My brother, an exercise physiologist and fitness specialist, told me that when a rest period (or "refractory" period) between stressful anaerobic activities is short, the ability to quickly recover your heart and breathing rate is vital. This will help ensure that sufficient oxygen is reaching muscle tissues and that performance at a high level can continue. Of course, rapid recovery depends on proper physical conditioning; an adequate hydration level; and experience that teaches you how to work smarter, not harder.

When donning your face piece or pulling up your protective hood, your helmet should be wedged firmly between your legs or under a bent knee so it doesn`t get lost. It is a good idea for all nozzle team members to become proficient in donning their SCBA face pieces, pulling up their protective hoods, and activating their PASS devices with gloves ON. Too many times, I have seen firefighters remove gloves to adjust SCBA straps or coat buckles, only to lose a glove in smoke or darkness or to have trouble getting it back on quickly, delaying the advance. Another reason for learning how to manipulate all your straps and buckles while wearing gloves is that during an SCBA emergency in a hot, smoky environment, there may not be time to remove and then redon gloves saturated with perspiration and water. In addition, it is simply too dangerous to expose your fingers and hands to possible burns and other injuries.

If an officer is present, he will call for water via his portable radio; otherwise, the nozzleman will have to do it. Once the line is bled, the officer (or nozzleman) must contact the ladder company firefighter(s) responsible for ventilation of the fire area. Timing the handline advance with ventilation is very important, and communication is the key. If ventilation is performed before a charged handline is in place, rapid fire growth and early flashover are real possibilities. If the ventilation comes too late or is not adequate to release the heat and expanding steam, the nozzle team will have a difficult advance and may be subject to burn injuries. The most common method of "venting for fire" is to simply remove the windows in the fire area opposite the advancing nozzle team. An exception might be a fire in a one-story "taxpayer" or strip mall. Extensive security measures may make horizontal ventilation at the rear of the building almost impossible. If ventilation is effected, it will be significantly delayed. In these cases, a large hole cut in the roof may be the only way to provide relief for the engine company advancing the handline and to help slow lateral fire spread. A top-floor fire in a multiple dwelling also requires a large roof hole in addition to extensive horizontal ventilation.

During the advance, all members of the nozzle team must be positioned on the same side of the handline. It is also very important that the nozzle team remain low and to one side of the opening to the fire area, using the door and wall as a shield against escaping heat and fire. If an officer is present, he may have to move to the other side of the door opening due to a narrow hallway or small landing. The officer must exercise extreme caution if this is required. Once the door is forced open, control of the door is vital to the success of the firefighting effort. (Some considerations in door control were discussed in Part 1.) Occasionally, by opening the entrance door to an apartment, the room or rooms involved in fire may be closed off by the open door--especially when you encounter "railroad flats." This makes for some difficult bends and turns and causes a delay in getting water on the fire.

A fire in one such apartment near FDNY Engine 48`s quarters required the forcible entry team from Ladder Company 56 to remove the entrance door. The safety of the firefighters on the handline was a key factor in this decision. Although they could advance the line around the door with some difficulty, evacuating the fire apartment in a hurry would have been impossible. Consider removing an apartment door as a last resort because it violates the principle of door integrity. In this case, the door was not removed until all tenants evacuating down the stairs had descended below the fire floor and the handline had started its advance on the fire with a continuous water supply behind it.

You MUST chock open any door through which the handline passes. Closing a door on an uncharged handline is like placing a hose clamp on the line. For more on the importance of chocking doors, see the sidebar "The Door Chock" by Michael N. Ciampo above. Remove storm doors and screen doors that will not stay open or do not open very wide. The nozzle team (and other firefighters) should also keep doorways clear and unobstructed. This permits an inrush of cool, fresh air to replace the heated products of combustion being displaced by the stream. It also maintains open the means of egress for any remaining occupants, firefighters performing rescue and/or removal operations, and firefighters in distress.

The sound of the stream can also provide clues as to the presence of a window or doorway. A doorway may lead to another room involved in fire. A window opening may allow the stream to be operated across an alley, shaft, or driveway to extinguish the burning sheathing or window frames of an exposure building. In addition, the nozzle pattern can be adjusted to ventilate the fire area. By changing a combination nozzle from straight stream to a fog pattern, effective negative-pressure ventilation is readily accomplished. In FDNY, some nozzlemen and engine officers carry a small, plastic, rotary fog tip (such as that found on standpipe "house line"), which can be quickly placed on the shutoff after removing the solid-stream tip. Even a solid stream, broken into coarse droplets by partially closing the nozzle shutoff, will move a substantial volume of air.

DANGERS OF KINKS

A recent series of tests conducted by FDNY Battalion Chief Peter Rice and involving engine companies 5, 14, and 33 sought to quantify the reduction in water flow caused by kinks. In each test, kinks were introduced into a 1 3/4-inch handline flowing 180 gpm. No more than one kink was placed in any single length of hose, and the changes in flow were noted using LED readout flowmeters, which had recently been recalibrated. Each kink was formed by making a bend in the hose of approximately 90 degrees. What Chief Rice found is that a single kink will reduce the flow by about 20 gpm. When a second kink was placed in the line, the flow dropped another 30 gpm for a total decrease in flow of 50 gpm. A third kink reduced the flow by another 40 gpm or so. As a result of three kinks, what is believed to be a 180 gpm fire stream may only be half that, and the potential for burn injuries is greatly increased. In addition to the loss of flow volume, the excessive turbulence also reduces the reach of the stream and causes premature stream disintegration when solid-bore tips are used. In a smoke-filled fire area, however, stream impact noise alone may not be sufficient to tell the nozzleman or officer that there is one or more kinks in the line.

It is very important that the backup firefighter (and the door firefighter, if available) "chase the kinks." The engine company chauffeur can certainly chase kinks in the vicinity of his apparatus; ladder company personnel, on entering the fire building and walking up the stairs, should not hesitate to remove kinks as they encounter them as well. After all, ladder company firefighters assigned to operate on the floor above the fire will be in the most severely exposed position if the flow from the handline is compromised by kinks.

ADDITIONAL CONSIDERATIONS

Here are additional thoughts on improving the safety and effectiveness of any handline advance.

Many times, a fire is self-vented on arrival and any prevailing wind is in the nozzle team`s favor. If only one or two rooms are involved, these conditions may permit use of so-called "hit and move" tactics: hit the fire, shut down, advance a little bit, and hit the fire again. Other situations require that the nozzle be kept open throughout the advance. This might be necessary when several rooms are involved in fire; if ventilation is inadequate; when the fire involves a large, open area with high ceilings; when battling a wind-driven fire; and when heat conditions are severe, such as during a fire in a high-rise residential or office building with concrete floors. Advancing a charged line with the nozzle open can be very difficult, particularly 2 1/2-inch hose. Additional personnel will be required to ensure that the handline keeps moving.

Oftentimes, simply finding the seat of the fire in a dense smoke condition can be a challenge. I discussed the necessary operation of the nozzle on smoke earlier, but in most cases, you should not open the nozzle until you locate the fire. While searching for the seat of the fire, move in the direction of greatest heat (which itself can be deceiving, especially in cellars or fire-resistive buildings). Look for the orange glow in the smoke near the ceiling. As mentioned earlier, shutting off handlights or turning them behind you is a good idea. Handlight beams reflected and scattered by opaque smoke particles may help hide the fire. Constantly monitor radio reports from other firefighters, those operating inside as well as outside the fire building. Always be alert to fire below you, especially in houses with balloon framing. What appears to be an upper-floor or attic fire may have originated in the basement or cellar. Use the same precautions at commercial building fires and check the cellar for fire early in the operation.

After you have darkened down the fire, shut down the nozzle so any remaining pockets of fire can "light up" for final extinguishment. Shutting down after knockdown also permits the smoke and steam to lift, improving visibility. Sometimes, you may have to keep the nozzle open to cool a superheated fire area after a post-flashover fire has been controlled. Especially when walls and ceilings are constructed of concrete, gypsum block, or gypsum board, additional cooling of the area to reduce reradiated heat may be required.

The use of a 100-foot lead length in the handline stretch may prove advantageous. By using a 100-foot length as opposed to the standard 50-foot length, the one coupling that always seems to get caught on stair treads, door jambs, and newel posts is eliminated, easing the burden when only two firefighters are advancing the handline.

If you are using nozzles with pistol grip shutoffs, be careful not to let the pistol grip slide back so that it ends up alongside your body. This interferes with nozzle movement and reduces efficiency. Try to keep the nozzle about an arm`s length reach out in front.

One more point concerning nozzles: A nozzle is one of the two or three most important tools used by an engine company. At the start of every tour (or at least weekly), members should remove each nozzle from the hose and examine its condition. Pay specific attention to proper operation of the bail and the condition of the gaskets. In addition, perform any required lubrication, set fog nozzles to straight-stream position, and restore each nozzle to the hose hand tight.

During overhaul, you can reduce nozzle pressures. You might also consider using a 1/2-inch outer stream or "overhaul tip" when using solid-stream nozzles. If the initial nozzle team is fatigued, relief personnel must be available to prevent needless injuries. An incident commander should never hesitate to call an additional alarm, summon off-duty personnel, or request mutual aid in anticipation of needed relief at a difficult fire.

A LIFESAVING TOOL

The first handline is, without question, the most important lifesaving tool at a structure fire. Controlling fire spread and stopping smoke production save an untold number of lives every year. While smoke has its greatest impact on civilians, it is the fire itself that most threatens firefighter safety. Stopping the generation of smoke and toxic gases--especially asphyxiating carbon monoxide--is the best means of safeguarding civilian lives. Firefighters, equipped with SCBA and able to operate in smoke, are more concerned with rollover and flashover. Controlling fire growth to reduce the potential for burn injuries is how the first line best protects firefighters.

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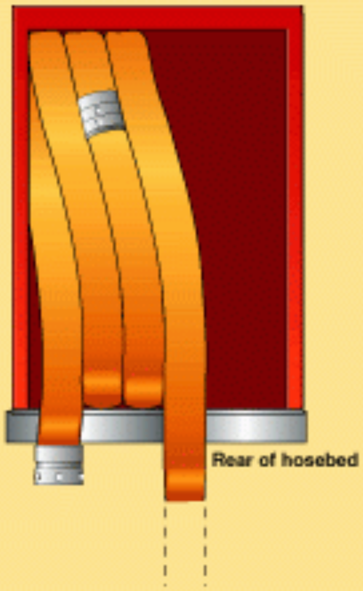
OBSERVATIONS ON THE ENGINE COMPANY

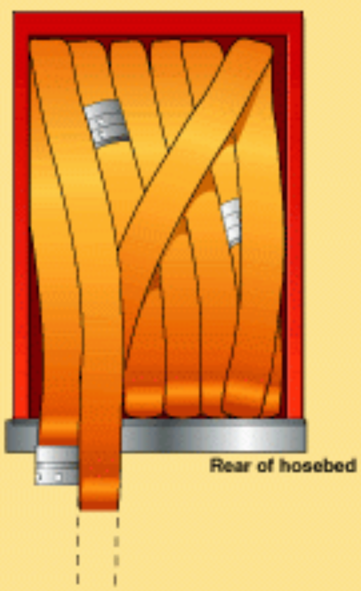
BY ANDREW A. FREDERICKS

This fire on the top floor of a five-story multiple dwelling in the Bronx, New York, required five lengths of hose within the fire building. Success in performing a "vertical" handline stretch depends on an accurate estimate of the hose needed to reach and cover the fire area, a hose load designed for the vertical stretch, and adequate training in stretching handlines in buildings with various stair configurations. (Photo by Matt Daly.)

The middle hose compartment on this Skokie, Illinois, engine contains a static load consisting of 450 feet of three-inch, two lengths (100 feet) of 2 1/2-inch handline fitted with a gated wye, and two lengths of 1 3/4-inch handline fitted with a "break-apart" nozzle. The two lengths of 1 3/4-inch hose are formed into a single horseshoe. The plywood deck on which the 1 3/4-inch handline rests was built to allow attachment of a nozzle to the 2 1/2-inch hose for deployment as a big handline without disturbing the smaller line (the deck has been pushed forward to reveal the hose below it). In all cases, the horseshoes are specifically sized to be carried, not dragged, and three-inch hose is used to "fill out" the hose loads due to its extremely low friction loss at standard handline flows. The hose compartment on the left also features a triple horseshoe finish. (Photo by Hank Sajovic.) (Bottom) These Skokie firefighters are stretching a large-flow handline from a static hosebed. This load is designed to be effective when deployed both horizontally and vertically. The lead or "working" length is an "inside" horseshoe--the 2 1/2-inch "shutoff pipe" (solid-stream nozzle) is on the inside so it rests on the nozzleman`s chest. Both the working length and the next length are 2 1/2-inch hose. The balance of the hose load (including the third horseshoe) is



One means of loading hose for the vertical type of stretch is used by FDNY. The hose is flat loaded beginning with the female coupling exposed at the left rear of the hose compartment. The hose is then loaded from left to right.



Unlike a standard flat load, however, once the first layer is completed, the hose is brought back over to the left rear of the compartment and the next layer is started. The process is repeated as necessary. The hose is removed in the opposite manner—from right to left—with each firefighter responsible for one length. Anywhere from three to five folds of hose can represent a full length, depending on the particular model of engine apparatus. Many engine companies form the first one or two lengths into a horseshoe to aid in grasping and removal.

three-inch. A total of 550 feet of hose is carried in this compartment. (Photo by Hank Sajovic.)

Anytime a handline is stretched, the nozzleman is responsible for the nozzle and at least one full length of hose. This is the "working length"--the hose needed to advance through the fire area and reach the seat of the fire. Depending on the size of the fire area, more than 50 feet of hose may be needed, so consider one length a minimum. (Photo by Robert Mitts.)

For decades, FDNY engines featured very low hosebeds to permit orderly and efficient hose removal. The bottom of the hosebed on this apparatus is approximately 19 inches above the rear step and was possible due to use of an "upright"- or "vertical"-style booster tank mounted behind the pump. (Photo by author.) Beginning in late 1992, FDNY began accepting delivery of new engines that incorporated many design changes over earlier models. One major change was the switch to a "coffin"-style or "T"-type booster tank to achieve better weight distribution and a lower center of gravity. As a consequence of this change, the bottom of the hosebed was raised to 45 inches above the rear step. This dramatic increase in height made hose removal much more difficult. In addition to the height, each new engine was equipped with a discharge elbow at the rear of the apparatus. A handful of tilt-cab models were provided with three discharge elbows; the high-pressure tilt-cab models, like the one pictured, have four. This creates yet another obstacle to reach over and around when stretching a handline. (Photo by Matt Daly.) The newest generation of FDNY engines features an "L"-shaped booster tank located partially beneath the hosebed. This new style of tank permits a hosebed that is only 33 inches above the rear step--a height much more accommodating to the firefighters using it. In addition to the height reduction, the length of the hosebed was reduced from 10 to seven feet,

making for hose folds of a more manageable length. The discharge elbow was also relocated to eliminate its interference when stretching handlines. (Photo by author.)

Even with a heavy fire condition on the first floor at the front of this house, the initial attack handline is being readied for its advance through the front door and not from the "unburned" side as recommended in many texts on firefighting tactics. The front door leads directly to the interior stairs, and protecting the integrity of these stairs is vital to the life safety of anyone trapped above the fire AND the firefighters searching to find them. The front door is also the easiest entrance to reach, and a shorter hose stretch is involved. This means faster water on the fire. If a straight or solid stream is used and the volume of flow is adequate, the fire will be quickly knocked down with little danger of "pushing" fire into uninvolved areas. (Photo by Robert Mitts.)

This firefighter is demonstrating how to form a charged handline into a loop and roll it as a means of advancing the line when staffing levels are compromised. Rolling the hose in this fashion is far easier than trying to drag it around sharp corners or over debris-covered floors. (Photo by author.)

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STANDPIPE SYSTEM OPERATIONS: THE STANDPIPE KIT

BY ANDREW A. FREDERICKS

With the many problems inherent in operating from a building`s standpipe system, a properly equipped standpipe kit will go a long way in making a difficult job less stressful. By planning in advance, you can assemble a standpipe kit that will ensure that the necessary fittings, adapters, wrenches, and other tools are readily available at the standpipe outlet selected for use. In addition to the standpipe kit that facilitates handline operations, a second kit can be assembled for the engine company chauffeur. This second standpipe kit can prove invaluable when a siamese connection poses difficulty or a standpipe system must be supplied through a lower floor hose outlet. Let`s examine these standpipe kits, the various causes of standpipe water supply problems, and the critical role the engine company chauffeur plays in troubleshooting these problems. In "Standpipe System Operations: Engine Company Basics" (Fire Engineering, February 1996, p. 33),1 I listed some of the tools and equipment carried in a typical Fire Department of New York (FDNY) standpipe kit. Now we will discuss each item in the kit and how to overcome various difficulties at the standpipe outlet.

The only way to know which specific problems exist in your jurisdiction is to get out and look at standpipe systems. Determine the type of system (Class I, II, or III) as well as its flow and pressure capabilities. Pay particular attention to the type and condition of the valve outlet threads and any indication that foreign objects may be in the riser or piping due to vandalism or malicious mischief. Try to get a general sense of the condition of the system and examine maintenance and test records. Walk the stairs, and check valve stems to ensure all valves are in the closed position. Measure the distance from each standpipe outlet to the farthest room in the most remote apartment or office area. Measure from the outlet on the floor below and from two floors below. A utility rope is excellent for this task. Scissor stairs should be properly identified at each floor landing on both the inside and outside of the stairway door. The siamese connection(s) must also be checked, as well as the fire pump and/or gravity tank. Verify the serviceable condition of nearby fire hydrants. If you perform these inspections on a regular basis, there will be fewer surprises during operations.

THE HANDLINE STANDPIPE KIT

Selecting Wrenches

Every standpipe kit should include a pair of spanner wrenches. Aluminum spanners are very light and easy to carry. They are useful for tightening hose butts and will provide sufficient leverage to loosen most caps and reducer fittings. When more leverage is necessary, a pipe wrench provides the solution. A pipe wrench is also useful when the control wheel is missing--particularly with a tight valve stem or one that is stripped, negating the use of a replacement wheel. Even when the control wheel is present, the pipe wrench may prove handy. The wrench can be attached to the spokes of the wheel to gain more leverage.

There are several considerations when selecting a pipe wrench for the standpipe kit. First, it must be a true pipe wrench (with serrated jaws--sometimes referred to as a stillson wrench), not a "monkey" wrench. Second, aluminum construction will provide a significant weight savings over traditional steel. Third and most importantly, ensure that the wrench is a minimum of 18 inches in length. If it is not at least 18 inches long, the jaws will not open wide enough to get a "bite" on stuck caps, reducer fittings, and pressure-restricting devices. A 20-inch wrench is better and ensures a clear jaw opening greater than 2 1/2 inches. If the 20-inch pipe wrench is too long to fit inside the standpipe kit bag, cut two inches off the end of the handle. You can also carry a short length of aluminum pipe (about 12 to 14 inches) and use it as a "breaker" bar. You can gain additional leverage by slipping the pipe over the handle of the wrench.

Vise grip or channel lock pliers do not provide as much leverage as a pipe wrench but may provide another option, especially when the outlet valve is located close to a wall or behind a door and the clearance is tight. Some engine companies fabricate a wrench with prongs that can be inserted between the spokes of the control wheel. (A photo of one such wrench appeared on page 38 of my February 1996 article cited above.)

According to FDNY Engine Company 36, engine companies in Harlem have had success using an oil filter wrench to remove stuck caps. Simply take a cap to your local automotive parts store, and select an oil filter wrench with the proper fit. A plumber`s strap wrench might also be an option.

A common reason for stuck caps is the use of dissimilar metals--most often aluminum replacement caps on brass outlet threads. In some instances, plastic caps are used, and engine companies in the south Bronx have found these caps attached with epoxy to prevent their theft. I have been told that the oil filter wrench will free some caps stuck or glued in place, but if the caps cannot be removed, only three options exist: (1) remove the threaded pipe nipple from the outlet valve body, and replace it with an adapter (this is discussed in the next paragraph); (2) hand-stretch a line up the stairs, if feasible; or (3) improvise a standpipe riser by stretching hose on the outside of the building. A seventh-floor fire on Roosevelt Island in New York City was extinguished by connecting the lengths of standpipe hose from two engine companies, lowering the hose out a sixth-floor window to the street, and then connecting it to hose from the supply pumper. Options two and three are usually limited due to time constraints, logistical considerations, and available personnel.

Thread Adapters

The next items to include in your kit are adapters, in case you encounter incompatible threads. Even if your community has only a handful of standpipe-equipped buildings, at the very least you should carry a female National Pipe Thread (NPT) to male local fire hose thread adapter in the standpipe kit. This adapter (actually just a pipe nipple or hose rack nipple) is traditionally constructed of brass and is rather heavy. It can be purchased in anodized aluminum and, in addition to being lighter in weight, is considerably smaller than the traditional brass nipple. One caution: At a glance, this particular thread adapter is easily confused with a 2 1/2-inch double male fitting (see photo on page 84). Color-coding the thread adapter to avoid a mix-up is a good idea.

Why is this particular adapter necessary? Male outlet threads may be missing due to vandalism, or perhaps they haven`t been installed yet on the upper floors of that new office building downtown. Another problem is that a cap may be glued in place or a fitting may prove to be so tight that when you apply force to remove it, the pipe nipple unthreads from the valve body with the cap or fitting still attached. Another pipe nipple must be immediately available as a replacement. Other adapters may be needed as well. There always exists the possibility that the male threads on the outlet valve are not compatible with local fire department hose threads. Especially if your fire department has its own hose threads (New York City, Chicago, Cleveland, Detroit, Pittsburgh, and several other cities) or uses thread other than National Standard Hose Thread (NHT or NST), problems are likely to crop up at some point. In New York City, these problems have been more pronounced in buildings constructed under the auspices of the state and federal governments, which bypass New York`s building code. To cope with incompatible threads, you must conduct pre-incident planning and seek input from field units regarding their problems at standpipe operations. Of course, you should demand remedies from the building owner/manager anytime you discover a problem, but carrying a thread adapter or two can save valuable time in the heat of battle. Consider color-coding each additional thread adapter to help reduce confusion on the fireground.

Additional Equipment

The next most important piece of equipment is the 2 1/2-inch by 2 1/2-inch in-line pressure gauge. Discussed extensively by John Grasso in "The In-Line Gauge" (Fire Engineering, February 1996), the type selected should be sturdily constructed, and the gauge itself should be large enough to be read easily and be suitably protected to prevent damage. Preset pressures based on two, three, four, and even five lengths of hose can be marked on the face of the gauge to ensure accurate nozzle pressures. Before attaching the gauge, remember to flush the system through the outlet to remove scale, rust, and any entrapped garbage and debris. Flushing through the standpipe outlet valve, just as hydrants are routinely flushed before hooking up, should be SOP.

The next piece of equipment is a nozzle. Even if a nozzle is preconnected to a length of hose, a second nozzle should be readily available in the standpipe kit. Nozzles have been known to break or clog at critical moments, and having another nozzle within a floor or two of the operation will save valuable time--and maybe lives. The nozzle in the standpipe kit should be identical to the nozzle preconnected to the hose and should be inspected with the same frequency as other nozzles carried on the engine. Hidden in the standpipe kit, this important nozzle is easily overlooked.

The need for solid bore tips and 2 1/2-inch handlines at standpipe operations is critical for firefighter safety. I have discussed this issue extensively in previous articles, so I will not belabor the point here. Each 2 1/2-inch nozzle should be equipped with a large (1

1/8-inch or 1 1/4-inch) main stream tip capable of at least a 250-gpm flow with proper pressure. In addition, a 1/2-inch "outer stream" or overhaul tip should be carried with the spare nozzle in the standpipe kit or in a turnout coat pocket. Should outlet pressures be critically low, the additional velocity pressure developed by the smaller tip may provide enough reach and penetration to allow ladder company personnel to reach and close the fire apartment door, save a civilian trapped in the hallway, or protect nozzle team members as they retreat to the safety of the stairway. In essence, the handline becomes a "super can," as it will produce a flow of only about 50 gpm at a 50-psi tip pressure--less if pressures are lower. Restrict the use of the smaller tip to emergency situations, and never use it as the standard attack tip.

Should it become necessary to extend a 2 1/2-inch handline without shutting the line down at the outlet valve, you should carry a 1 1/2-inch by 2 1/2-inch increaser in the kit. This allows you to add hose at the 2 1/2-inch nozzle shutoff simply by unscrewing the tip and attaching the increaser. You can then attach the spare nozzle from the standpipe kit (or from another engine company) to the new section(s) of hose and resume the fire attack. Always be sure to secure or protect the bail of the nozzle to which the extra hose is attached to prevent accidental closure.

The Los Angeles City Fire Department devised a rather ingenious solution to the problem of extending handlines and the need to find and attach another nozzle. While I disagree with the use of fog tips during standpipe operations, the LA nozzle features a dual shutoff. A standard ball shutoff is provided, but the low-pressure fog tip is itself a rotary controlled nozzle. The fog tip is removed, additional hose is connected to the ball shutoff, and the fog tip is reattached to the end of the new hose and the fire attack continued.

Another important item to carry as part of the standpipe kit is a wire brush. When threads are covered with dirt, paint, or sprayed-on insulation, a wire brush will be necessary to clean the threads and permit attachment of the in-line pressure gauge. Every standpipe kit should also include several door chocks and perhaps a latch strap or two. Many standpipe kits also include replacement hand wheels for attachment to the valve stem when the regular wheel is missing. There is nothing wrong with carrying spare hand wheels, but damaged valve stems, the many different sizes and shapes of valve stems, and the difficulty in holding the replacement wheel in place and/or developing enough force to open the valve with it, make the pipe wrench the better choice.

A final consideration in organizing the standpipe kit is protecting any exposed male threads from damage. Damaged threads on a fitting or adapter are as dangerous as not having the proper fitting or adapter at all. Although some fittings and adapters can be connected as a means of protecting the male threads, others cannot. Two simple solutions exist in this latter case. The first is to attach a plastic "blind" cap. Plastic caps are lightweight and, unlike metallic caps, there is no possibility of an oxidation reaction. A second solution is to wrap any exposed male threads with a piece of bicycle inner tube cut to size.

Transporting the Kit

Some departments attempt to carry their wrenches and adapters inside the same bag as the hose, but I suggest utilizing a separate bag. Although I have seen tool boxes (both metal and plastic) used as carriers for standpipe kits, a durable, soft-sided bag is better. In FDNY, tool bags for carrying the standpipe kits are issued to each engine company. These bags are available at most hardware stores. Some engine companies use old mail sacks. Bags are also available from various fire equipment manufacturers. It is very important to attach a shoulder strap to the bag. This will allow the firefighter assigned to the kit to keep one hand free, even if he is also carrying hose or other equipment.

THE CHAUFFEUR STANDPIPE KIT

The chauffeur standpipe kit was born of necessity--specifically to meet the need of having various fittings and wrenches close at hand when supplying a standpipe system through a lower-floor hose outlet. The following example illustrates its importance.

In FDNY, SOPs require that standpipe and sprinkler systems be supplied with 3 1/2-inch hose. The 3 1/2-inch hose used by FDNY has three-inch couplings and is normally loaded with the male coupling on top. With all siamese connections in New York City required to have three-inch swivels, the 3 1/2-inch hose can be immediately made up to the connection. Difficulties are encountered, however, when it is necessary to supply a standpipe system through a first- or second-floor hose outlet, which might be necessary because of a damaged or vandalized siamese connection or the need to reinforce augmentation with an additional supply line. Since standpipe hose outlets consist of 2 1/2-inch male threads, making up a connection between the male three-inch coupling on the supply hose and the male 2 1/2-inch threads on the outlet requires both a sound knowledge of fittings and a means of ensuring that they are readily available when needed--hence, the chauffeur standpipe kit. Before I explain which specific fittings you should carry in the kit to solve this problem, a review of some basic rules governing the use of fittings is in order.

Proper Use of Fittings

Solving any problem involving fittings is a three-step process that can be summed up as follows: SEX-SIZE-SOLID to SOLID. Same-sex couplings that must be connected (male to male or female to female) should be handled first. Very simply, the use of a double male or double female fitting will be required. The second step is to solve any existing size problem. Size problems are handled by employing reducers and increasers. All firefighters should be able to differentiate between thread sizes by a visual examination and by touch--with firefighting gloves on. While 1 1/2-inch and 2 1/2-inch threads are easily distinguished, the differences between 1 1/2-inch and two-inch threads or 2 1/2-inch and three-inch threads are more subtle and require training for prompt recognition. The third and final step is to thread any solid fitting (reducer or increaser) onto the solid (male) coupling. Once the solid fitting is connected to the solid coupling, then the female swivel can be made up.

So let`s return to the problem involving the male 2 1/2-inch outlet and the male three-inch coupling. First, the sex problem is handled by use of a 2 1/2-inch double female. Next, the size problem is overcome by use of a three-inch to 2 1/2-inch reducer. This fitting is then threaded onto the three-inch male end of the supply hose (solid to solid). The reducer is then attached to the double female, and the connection is complete. An alternate method of solving this problem is to utilize a three-inch double female on the hose and then connect a 2 1/2-inch by three-inch increaser to the outlet. While either way is acceptable, the key is to carry the required fittings in the chauffeur standpipe kit. In addition to various fittings, the same thread adapters and wrenches carried in the handline standpipe kit should be included as part of the chauffeur`s kit. A wire brush and door chocks are also necessary. A durable canvas bag or sack is ideal for carrying the equipment, and a shoulder strap should be provided.

Additional Equipment

Even when a siamese connection is used for supplying a standpipe (or sprinkler) system, items can be added to the chauffeur standpipe kit to help overcome various problems. The first additional tool is a male blind cap, which can be important if it becomes necessary to plug one side of an uncapped siamese connection with a malfunctioning clapper valve. Including oversize spanner wrenches or hydrant wrenches that incorporate pin lug spanners is another good idea. When you encounter a tight cap, the large spanners and/or hydrant wrenches will provide much more leverage than standard spanners. The handles on these wrenches also make excellent probes and may facilitate removal of garbage and debris without the risks associated with placing your fingers or hand inside the connection. Including both a double male and double female fitting will permit rapid connection of the supply hose even when the female swivels on the siamese connection are "frozen" and will not turn. The biggest issue now becomes the weight of the kit, so some of the items used less frequently may have to be carried elsewhere. A flashlight or hand light should be readily available for locating hidden connections, determining what type of system the connection supplies, and examining the position and condition of the clapper valves.

SUPPLY VIA A LOWER-FLOOR OUTLET

When attempting to augment supply to a wet pipe standpipe system via a lower-floor hose outlet, keep several considerations in mind. The first is the additional hose needed to reach the outlet. Depending on the distance, obstacles such as doors and fences and the weight of the hose employed can cause considerable delay in establishing augmentation. Second, the question of whether it is possible to augment the system through a lower-floor hose outlet must be answered. The presence of pressure-regulating devices may delay or even preclude augmentation altogether. Although pressure-restricting devices can be removed and pressure-restricting valves can be defeated, pressure-reducing hose outlet valves cannot be "back-fed", negating their use for augmentation. A third issue concerns when the hose outlet valve should be opened. It is very important not to open the valve prematurely. Communication between the firefighter responsible for opening the valve (oftentimes the second- or third-due engine chauffeur) and the first-due engine chauffeur is vital. After flushing the system through the outlet and connecting the hose, opening the valve must be timed with the chauffeur`s readiness to supply water. The chauffeur must be properly connected to a hydrant and the supply hose attached to a discharge outlet. If the nozzle team has started its attack on the fire using gravity tank pressure, opening a lower-floor hose valve will reduce the nozzle pressure and the volume of water being applied on the fire. Any reduction in water pressure could compromise the safety of the nozzle team and firefighters performing search operations. Timing the valve opening will permit augmentation to begin smoothly with little impact on nozzle pressures. In departments with inadequate staffing, the first-due pump operator may be completing these tasks alone, in which case the nozzle team should be informed that alternative augmentation tactics are required and that there may be a temporary drop in pressure.

CAUSES OF PRESSURE PROBLEMS

Often, poor nozzle pressure at standpipe operations is caused by kinks in the handline. Charging a 2 1/2-inch handline within the narrow confines of a stairway enclosure inevitably leads to kinks but is sometimes necessary for the safety of the nozzle team.

Another cause is an insufficiently opened outlet valve. If the outlet valve is opened while the nozzle is still closed (static condition), the hose will feel rigid, and the in-line gauge will show what appears to be adequate pressure. Once the nozzle is opened, however, the pressure will drop, and a poor fire stream will result. The firefighter assigned to open and adjust the outlet valve must remain at his position until the nozzle is fully opened, making adjustments as necessary. Always be certain to remove any pressure-restricting device or to ensure that the pin limiting travel of a pressure-restricting valve is removed.

A third possible reason for inadequate nozzle pressure is a partially or wholly closed outside screw and yoke (OS&Y) or post indicator valve (PIV). PIV and OS&Y valves are employed in standpipe systems as zone or section valves. They are used to isolate portions of risers, individual risers, or even entire building standpipe systems to facilitate maintenance activities. If a closed control valve is not to blame, have a firefighter check to see if the pipe from the siamese connection is attached to the standpipe riser. On more than one occasion, an engine chauffeur has filled a basement with water as a result of a broken or detached pipe from the siamese connection.

Another potential problem involves manual dry pipe standpipe systems. In areas with rampant vandalism, large numbers of open hose outlet valves will steal valuable pressure from the handline operating on the fire. These valves will have to be closed, and a team of firefighters should be dedicated to this task. A similar problem can exist in buildings under construction or, worse, when the top of the riser being supplied has not been properly capped and water will be pumped out the top. A deputy chief from the Utica (NY) Fire Department told me of a building in which the standpipe riser has been cut in half by vandals. The department`s method of bypassing the standpipe system consists of placing an aerial ladder or elevating platform at a window one floor below the fire, substituting the waterway on the aerial or platform for a standpipe riser. Remember, anytime an aerial ladder, elevating platform, or tower ladder is used in this fashion and the fire is on or below the tenth floor, ensure that at least one other aerial device is available for firefighter rescue.

TROUBLESHOOTING

The engine company chauffeur plays perhaps the most important role in troubleshooting supply and augmentation problems during standpipe operations. Besides securing a reliable source of water from a nearby hydrant, he must ensure that an adequate volume of water at proper pressure reaches the operating nozzle. One valuable tool to help with this mission is the flowmeter--yes, the delicate, misunderstood, and still far-from-perfect flowmeter. My experience with flowmeters is that many fires are extinguished so quickly that the flowmeter never enters the picture as a means of ensuring that sufficient gallons per minute are being delivered. Another issue concerns a lack of maintenance and recalibration, which makes the flowmeter suspect and hence forgotten even when its use would benefit operations. Still other problems relate to the design of the instrument and its often fragile construction, which may contribute to breakage under the heavy wear and tear placed on many engine apparatus. Still, despite their flaws, flowmeters should not be ignored and, when properly and regularly calibrated, can be a tremendous asset during standpipe operations.

Let`s examine two situations where monitoring both the discharge pressure gauge and flowmeter can provide clues as to what type of standpipe supply problem exists. In the first situation, the nozzle team indicates poor nozzle pressure or no stream at all and states that the outlet valve is fully open, there is no pressure-regulating device involved, and kinks are not the problem. If the pump pressure has been increased to a point at or above the required discharge pressure and the nozzle team has verified the nozzle is fully open, observe the flowmeter. If the flowmeter shows a very low flow or indicates a zero flow condition, a partially or completely closed zone or section valve is most likely the culprit. Firefighters must be dispatched to locate and open the offending valve. OS&Y valves are most often found in stairways, usually at ceiling level. A "suitcase" or A-frame ladder may be required to reach the valve. The valve may be in the basement or cellar, so check this location as well. In the case of a PIV, it will be found outside in close proximity to the building. The presence of a freestanding siamese connection located some distance from the building hints that PIVs are used as zone valves.

In the second situation, the nozzle team again has poor nozzle pressure and kinks, or problems with the outlet valve are ruled out as the cause. This time, however, the engine chauffeur notes a drop in discharge pressure and a rather large reading on the flowmeter, perhaps well above the 250-gpm discharge typical of 2 1/2-inch hose. In this case, a closed valve is not the issue but, rather, open valves. In the case of nonautomatic dry standpipes, open outlet valves on intermediate floors will rob valuable pressure and volume from the operating nozzle and will have to be closed. The riser itself may be damaged or cut as described above, negating its use and forcing companies to utilize other risers or alternative supply procedures. If another riser is utilized and the risers are interconnected, it will be necessary to close a zone valve to isolate the broken riser and allow development of proper nozzle pressures. A broken or detached pipe from the siamese connection may result in a flowmeter reading of 1,000 gpm or more. In this situation, augmentation will have to be performed using lower-floor hose outlets. No matter what the specific water supply problem, the engine company chauffeur plays a key role in identifying the problem and helping to overcome it.

CHAUFFEUR SAFETY

Wearing turnout gear and a helmet is a good idea for the engine company chauffeur when operating in the street below an upper-floor fire. In some cases, even this is not enough to prevent injury. About three years ago, an engine company chauffeur at a multiple-alarm fire in Manhattan was struck by a piece of falling glass while checking a siamese connection. The glass sliced through his turnout coat and lodged in his back, partially severing his spinal cord. He retired on disability and remains partially paralyzed. Glass shards falling from the upper floors of a high-rise building have been known to travel great distances horizontally, widely expanding the danger zone and the risks posed to firefighters in the street. Heavy chunks of glass, besides slicing hoselines like soft butter, have become embedded in apparatus roofs and paved surfaces, creating further hazards.

In addition to falling glass and debris, engine chauffeurs should respect the high pump pressures sometimes required at standpipe operations. Supply lines should always be attached to the officer`s side of the engine or at the rear to prevent injury to the chauffeur in case of failure. Expect burst lengths from time to time, and have a contingency plan. Be aware of the difficulty in hearing radio transmissions when pump rpm's are high. A headset-type radio is a good idea. Remember the high static pressure that will build in the hoseline when a nozzle is closed at an upper-floor fire. It may be better to keep the nozzle cracked opened use apparatus relief devices.

EXPECT THE UNEXPECTED

Standpipe operations are, more than most other firefighting operations, governed by Murphy`s Law. Just about anything that can go wrong will--and usually at the worst possible moment. At one Bronx fire, the nozzle tip became clogged with a crack pipe. At another fire, a building`s hot water system was tied to the standpipe riser, and scalding water discharged from the hose outlets. Failure to remove a pressure-restricting device at a "project" fire reduced the nozzle pressure and caused burns to a nozzle team. The list goes on and on. Planning for standpipe operations means anticipating what can go wrong and preparing for it. Preparation includes familiarizing yourself with local standpipe systems, conducting regular drills and training, and using well-equipped standpipe kits.

Endnote

1. For further reference, see "Return of the Solid Stream" (Fire Engineering, September 1995, p. 44-56), "Standpipe System Operations: Engine Company Basics" (Fire Engineering, February 1996, pp. 33-42), and "The 2 1/2-Inch Handline" (Fire Engineering, December 1996, pp. 36-49).

This is FDNY Squad Company 18`s second standpipe kit, dedicated for use by the squad (engine) company chauffeur. The kit contains two spanner wrenches, oversize spanner wrenches (not pictured), an 18-inch pipe wrench, a female NPT (National Pipe Thread) to male FDNY thread adapter, a male NST (National Standard Thread) to male FDNY thread adapter, a three-inch male blind cap, a 2 1/2-inch double female fitting, a three-inch to 2 1/2-inch reducer fitting, a wire brush, and a flashlight. The chauffeur standpipe kit is invaluable when you encounter problems with a siamese connection or when you must supply a standpipe system through a lower-floor hose outlet. (Photos by author unless otherwise noted.)

Here a standpipe system is being supplied through a first-floor hose outlet. This procedure may be necessary because of a damaged or vandalized siamese connection or to reinforce augmentation with an additional supply line. Anticipate what fittings, adapters, wrenches, and other tools might be required for this operation, and carry them in a second standpipe kit dedicated for use by the engine company chauffeur.

Sometimes the female swivels on a siamese connection are "frozen" because of paint or trapped dirt. If you cannot free them, you can improvise a swivel by attaching a double male fitting followed by a double female. Here the fittings are preconnected to the hose used to supply standpipe and sprinkler systems, eliminating a desperate search for them at that 3 a.m. fire.

(Top left) In this photo, an oversize spanner wrench is being used in conjunction with a combination hydrant/spanner wrench to free a tight cap. Note the missing pin lug from the cap on the left. If both pin lugs are sheared off, a pipe wrench will be needed to remove the cap. Include in the chauffeur standpipe kit a set of wrenches to handle problems at the siamese connection. (Photo by Jerry Tracy.) (Top right) On the left is a brass pipe or hose rack nipple used to connect the female NPT threads of the hose outlet valve with occupant use hose installed on the rack. When male outlet threads are missing as a result of vandalism or because they haven`t been installed yet, or when they unthread during attempts to remove a stuck cap, reducer fitting, or pressure-restricting device, new male threads must be available to make the standpipe hookup. Carrying a hose rack nipple in the standpipe kit provides the solution. In the center is a lightweight version of the same adapter. Note how it might be confused with the 2 1/2-inch double-male fitting on the right. Color-coding the adapter is a good idea. (Bottom left) If you must extend a 2 1/2-inch handline quickly without shutting the line down at the hose outlet, a 1 1/2-inch by 2 1/2-inch increaser provides the answer. Simply remove the nozzle tip, attach the adapter, and add lengths of hose as necessary. The spare nozzle carried in the standpipe kit or a nozzle from another engine company is then attached to

the new section(s) of hose. (Bottom right) This is a 1 1/8-inch nozzle tip clogged by a primitive crack pipe during a standpipe operation. It speaks both for the importance of flushing the riser at the outlet valve before connecting the handline and for carrying a spare nozzle in the standpipe kit.

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LONG HANDLINES AND HOSE HEADERS

BY ANDREW A. FREDERICKS

This column consists of two parts. First, let`s take a look at how one volunteer fire department has met the challenge of long, complex handline stretches. In "Observations on the Engine Company" (Fire Engineering, April 1998, pp. 83-96), I differentiated between horizontal and vertical handline stretches. I also discussed two separate five-story apartment building fires that in each case caused extensive fire, smoke, and water damage to the upper floors. Previous experience at these types of fires suggested that a delay in placing handlines into service was largely to blame. Reading this, members of the Dobbs Ferry (NY) Fire Department (one of the departments involved) took exception, since members were well practiced in the vertical handline stretch. The problems they encountered at this fire were not due (as is often the case) to a lack of preparation, training, or sufficient personnel. They had all their "ducks in a row" but were met with exceptionally difficult fire conditions and numerous extenuating circumstances.

The Village of Dobbs Ferry is situated along the Hudson River, 12 miles north of New York City. Recognizing the difficulties posed by an upper-floor fire in each one of three five-story non-standpipe-equipped apartment houses located in the village, the department drafted prefire plans that included estimates of how much hose would be needed to reach upper-floor fires. Hose loads were reconfigured accordingly, and each of the department`s three engines incorporates two static or bulk hose loads carried at the rear of the apparatus. One static hose load consists of four lengths (200 feet) of 1 3/4-inch hose filled out with a minimum of four lengths of 2 1/2-inch hose. An adjacent hose compartment contains 10 lengths (500 feet) of 2 1/2-inch hose. Both lines are fitted with solid-stream controlling nozzles. If the fire area is beyond the reach of preconnected lines, the needed amount of hose is stretched from the static beds. This hosebed arrangement, coupled with regular practice in stretching handlines upstairs, allows the critical first line to be placed into service quickly and efficiently.

H-TYPE APARTMENT BUILDING FIRE

On December 15, 1997, at 1818 hours, the Dobbs Ferry Fire Department was dispatched to a reported explosion in a five-story, 200x75-foot H-type apartment building of ordinary construction. Less than 2 1/2 minutes after the first 911 call, one of Dobbs Ferry`s chief officers arrived to find heavy fire venting from two top-floor windows in the A wing of the building. By the time the first-due engine commenced its 1 3/4 handline stretch (four minutes after the first 911 call), fire was already showing from five windows, and it appeared to have extended into the cockloft. Only six minutes and 23 seconds after the first report of an explosion, the first-due engine company was asking for its line to be charged. A 2 1/2-inch backup line was being stretched, and mutual aid had already been summoned. A vent hole placed in the roof by the first-arriving ladder company revealed the fire did indeed have a significant foothold in the cockloft.

To complicate the situation, a civilian was trapped on a fifth-floor fire escape, cut off by the rapidly expanding fire. The civilian was safely removed by tower ladder basket, and primary searches in those top-floor apartments that could be entered proved negative. After 20 minutes of arduous handline operations and verification that all occupants had been evacuated, the incident commander switched to exterior master streams. A partial roof collapse had also occurred, and the dangers posed to interior forces were too great. Exterior streams were operated until the cockloft fire was subdued. Final extinguishment was effected using handlines.

LESSONS LEARNED

Heavy fire damage was incurred to the roof, cockloft, and four top-floor apartments. The remaining top-floor apartments suffered varying degrees of fire damage, with smoke and water damage throughout the building. The fire apparently started when spray paint vapors ignited, causing an explosion. Rapid spread of the fire prior to fire department arrival--particularly the early involvement of the cockloft--presented the Dobbs Ferry Fire Department with a formidable challenge that members met with skill and determination. They are to be commended not only for their efforts at this fire but also because they were prepared for the long and difficult handline stretches to the fifth floor. Lessons learned and reinforced include the following:

-When preconnected lines fall short, static hose loads provide the solution. Designed for horizontal and vertical stretches, they allow efficient deployment of long handlines.
-Prefire planning is essential. Identify buildings that require long hand stretches, and estimate how much hose is required.
-Training saves time. Training in stretching handlines pays off. The first-due engine company at this fire had its line in position on the fifth floor less than 2 1/2 minutes after arriving at the scene.
-The first handline is critical. It must be stretched and charged as quickly as possible with all necessary resources directed to this task.
-The backup line should always be at least the same size (diameter) as the initial line. Remember, the primary reason for stretching the backup line is to protect the firefighters operating the first line.

AUGMENTING SPRINKLER SYSTEMS

Now let`s discuss the augmentation of sprinkler systems when siamese connections are vandalized or otherwise unusable. Unlike standpipe systems, there are no lower-floor hose outlets that offer a means of supply or augmentation. There is, however, an alternative, provided the automatic sprinkler system is equipped with a fire pump. In this case, augmentation may be performed using the hose header. Hose headers (otherwise known as test headers, test manifolds, or test connections) are used for testing and certifying fire pump performance as per NFPA 20, Standard for the Installation of Centrifugal Fire Pumps. Hose headers may be found freestanding outside the building, on an exterior building wall, or inside the building, sometimes in the fire pump room. If the siamese connection(s) cannot be used, augmentation can be performed by pumping into the hose header. This procedure can also be employed if the fire pump is out of service.

I first learned of this technique from an article entitled "Hose Headers ... Additional Info" by Battalion Chief Milton Brodey (WNYF, 1st Issue, 1966, pp. 22-23). Brodey describes various uses of the hose header, including as a means of augmenting a sprinkler system. He describes the steps to be followed:
1. Remove caps from 2 1/2-inch outlets to be used on hose header, and connect hoselines from pumper.
2. Open 2 1/2-inch gate valves. (These valves are the non-rising stem type and open counterclockwise.)
3. Gain access to building, follow the hose header piping to its connection, and open up the OS&Y gate valve controlling the hose header.
4. Operate pumper to supply necessary water and pressure.

I asked Glenn Corbett, P.E., Fire Engineering technical editor and fire protection engineer, if this method is feasible and what concerns might exist. He said that it is indeed feasible, but additional friction losses should be anticipated as water is pumped through the hose header and into the discharge side of the fire pump, depending on the length of that pipe. Reports of sprinkler head performance should be sought from firefighters operating in the building, and the fire department pumper discharge pressure (PDP) should be adjusted as necessary. It is important to trace the pipe between the hose header and fire pump to ensure it is connected. Due to its infrequent use, poor maintenance, and vandalism, a broken or disconnected pipe is a distinct possibility. In addition, an undersized pipe will create more friction loss, further increasing the required PDP. Verify that the correct hose header is being supplied if there are multiple fire pumps and hose headers.

Other concerns during this operation include the following:
-Fittings are required to connect the male threads on the supply hose to the male threads on the hose header outlet(s).
-Threads on the outlets may not be compatible with the local fire department hose thread, in which case adapters must be used.
-Appropriate wrenches should be readily available to handle stuck caps and tight valve stems.
-Non-indicating 2 1/2-inch gate valves should be opened fully during augmentation operations.
-Gate valves may be missing from some hose headers and replaced with blind caps. In this situation, simply remove the needed number of caps (a pipe wrench will be necessary) and attach the hoselines.
-Always ensure that the control valve(s) between the fire pump and hose header is fully open. The control valve should be an indicating type, such as an OS&Y, or an indicating butterfly type.
-When the hose header is located inside the building, additional hose is needed to reach it. In all cases, access to the pump room is required to monitor pump performance. If keys are not forthcoming, forcible entry will be necessary.

-Ensure that the hose header pipe is drained after the operation. This may involve opening a drain on a low point in the piping if an automatic ball drip is not installed.

If the fire pump is out of service, it may be possible to reinforce augmentation by pumping into the hose header in addition to the siamese connections. In this case, the pump can be bypassed by rerouting the water around the pump. Pump bypasses are often installed on fire pumps. There are two additional points concerning augmentation of automatic sprinkler systems. First, in some instances, pressure-regulating devices--specifically pressure- control valves (PCVs) and pressure-reducing valves (PRVs)--are installed on sprinkler systems to control pressures. Depending on the type of pressure-regulating device employed and its preset pressure, successful augmentation may be difficult, if not impossible, especially if a large number of sprinkler heads have fused and high-pump pressures are required. Attempt to determine the presence of PCVs and PRVs during prefire planning. Be especially alert to the presence of PRVs on combination sprinkler/ standpipe systems in tall buildings.

Second, while we are on the subject of tall buildings, check your department`s SOP regarding the required pump discharge pressure when augmenting sprinkler systems, keeping in mind the pressure limitations of the system`s piping and fittings. In my experience, the figure most often quoted is 150 psi. Although this may be adequate for a one-story building, what about the elevation loss that must be overcome when sprinkler heads fuse on the 22nd floor? Always remember to compensate for elevation losses when augmenting sprinkler systems. Some jurisdictions require that the needed pressure be stamped or printed on a sign near the siamese connection. Another solution is to change your SOP to read "for augmenting sprinkler systems, pump at 150 psi plus five psi for each floor above grade level." The only way to know what floor the fused sprinklers are on is to communicate with firefighters operating in the fire building.

Finally, in "Standpipe System Operations: The Standpipe Kit," (Fire Engineering, February 1999, pp. 71-86), I discussed the selection of wrenches for inclusion in the standpipe kit. On page 72, I indicated that a 20-inch pipe wrench is better than an 18-inch pipe wrench because the clear jaw opening on the 20-inch wrench is "greater than 2 1/2 inches." Actually, the jaw opening on both wrenches is considerably greater than 2 1/2 inches, so the sentence should have read as follows (revised text in italics): "A 20-inch wrench is better and ensures a clear jaw opening sufficient to fit around all types of caps, fittings, pipe nipples, and pressure restricting devices." Although the 18-inch wrench should be adequate, the 20-inch wrench provides increased versatility and peace of mind.

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ENGINE COMPANY SUPPORT OF RIT/FAST OPERATIONS

BY ANDREW A. FREDERICKS

The search for, rescue of, and removal of injured, lost, and trapped firefighters have developed into formalized disciplines with the creation of rapid intervention and firefighter assist and search teams (RIT/FAST). These teams, trained and equipped with a variety of hand tools, power tools, and search ropes, have been instrumental in saving firefighter lives around the country. Although the RIT/FAST may at times employ protective fire streams, specific procedures covering the emergency use of handlines and master stream devices rarely exist. The fact remains that, especially when rapid fire spread or collapse occurs, the prompt application of water may be the only means of saving trapped firefighters and protecting members of the RIT/FAST during rescue and removal efforts.

ENGINE COMPANIES SAVE LIVES

We know that the first handline stretched at a structure fire saves more lives than any other action performed on the fireground. Since fire control goes hand in hand with life safety, it makes absolute sense that engine company operations should be an integral part of any firefighter rescue and removal protocol. The following selected examples dramatically illustrate that many firefighter rescue efforts, even those that are ultimately unsuccessful, depend heavily on the engine company.

At the tragic 23rd Street collapse in Manhattan on October 17, 1966, that claimed the lives of 12 firefighters and officers, only the Herculean efforts of the firefighters pushing back the fire with 2 1/2- inch handlines allowed rescue teams to reach the trapped members. The following is a description of the rescue attempt taken from an official report on the fire:

After the collapse of the drugstore floor, Chief Hay organized the personnel in front of the drugstore and directed them to pull the two hoselines from the store in order to use them to drive the fire back and reach the men in the store. Both lines were inextricably trapped and could not be withdrawn. Another hoseline was connected, and a rescuing party entered the store and fought their way toward the rear in the face of almost unendurable physical conditions. At one point in their battle to reach the twelve men, fire appeared behind them at the front of the store, which would have cut off any chance of escape. This fire was controlled by another hoseline which had been brought into operation, and the men continued to advance the original line.

On March 12, 1987, the Detroit (MI) Fire Department lost three firefighters at a commercial building fire. In an odd set of circumstances, an officer and firefighter were killed by the collapse of a fire wall; another officer was killed in a fall from a third-floor window after being trapped by rapid fire spread. The tragedy would have been greater still had it not been for the alertness and initiative of the chauffeur from Engine Company 10. Noting that a firefighter was trapped at another third-floor window, he quickly trained a deckpipe stream into the window opening and was able to keep the flames away from this firefighter until a portable ladder could be raised for his rescue.

At the World Trade Center bombing in New York City on February 26, 1993, firefighter Kevin Shea of Fire Department of New York (FDNY) Rescue Co. 1 fell into the crater created by the blast and suffered severe injuries. Firefighter Shea, communicating over his portable radio, was able to direct hose streams through the dense smoke and drive the encroaching fire from his location. He later said: "I knew they could hear me: Streams were crisscrossing from different floors to hit the fire around me and protect me .... These engine operations really helped save my life." There are, of course, many more examples, but space limitations preclude mentioning them here.

FROM "FAT" ENGINES TO "FAST" TRUCKS

Although many fire departments use ladder companies as RIT/FAST units, in some departments, engine companies assume this important role. Considering that there are more engine companies than ladder companies in the majority of fire departments, the choice of an engine company as the RIT/FAST should not be surprising. The drawback, however, is that most engine companies lack the training and equipment to function as an efficient RIT/FAST. About seven years ago, FDNY adopted a policy whereby an engine company would be designated as the "Firefighter Assist Team" or "FAT" engine (no pun intended) and assigned to every working fire. Like other departments, engine companies were available in greater numbers than ladder companies, so the policy on its face appeared to make sense. It soon became evident, however, that engine companies were ill-equipped to fulfill this vital function. Shortly thereafter, ladder companies were given this responsibility and were designated as "FAST" trucks.

THE RAPID INTERVENTION ENGINE COMPANY

An effective RIT/FAST requires personnel experienced in forcible entry, laddering, search, and other "traditional" truck company duties. Although all firefighters should be competent in both engine and ladder work, the fact remains that members of truck, rescue, and squad companies perform these tasks routinely and are usually more proficient in them. In addition, they carry the tools and equipment necessary for freeing and removing entrapped firefighters. But this in no way, shape, or form diminishes the role of the engine company. Quite the contrary. Since many times firefighter rescue efforts can`t even be attempted without protective fire streams, the engine company`s role in RIT/FAST operations assumes major significance. For this reason, a prudent incident commander (IC) will ensure a means of quickly deploying a firefighter rescue handline by requesting a RIT/FAST engine company (hereafter simply called the "rapid intervention company--engine" or RICE) in addition to the normally assigned RIT/ FAST unit. Very large or complex buildings may warrant a second or even a third RICE to ensure prompt handline placement when firefighters become trapped or endangered. Staffing levels may be another consideration in special-calling another RICE. When staffing is light, it may take two engine companies together to deploy a single rescue handline.

TRAINING AN EFFECTIVE RICE

Training continuously and realistically in both "routine" and not-so-routine fireground operations is essential for an effective RICE and should encompass three critical areas: skill-specific training in stretching and advancing handlines of various sizes; physical strength and endurance training to help firefighters withstand the punishment of firefighter rescue operations; and developing mental toughness so that they can withstand the emotional rigors of firefighter rescue efforts--especially when they are unsuccessful.

The primary skill required by the RICE is the ability to deploy and advance a handline as quickly and efficiently as possible. Although this is a basic engine company function, in firefighter rescue, the difficulties faced when performing this task may be considerable. Engine company members should practice stretching handlines over a variety of stair configurations, over fire escapes, on the outside of buildings using utility ropes, and over both portable and aerial ladders. Both medium-diameter (1 3/4- and two-inch) and large-diameter (2 1/2-inch) hand-lines should be stretched. In addition to stretching dry handlines, firefighter rescue may necessitate moving charged handlines from one level to another. Drills should include moving charged lines up different types of stairways, over fire escapes, over both portable and aerial ladders, and through window openings of different sizes and shapes. Operating handlines from ladders should also be practiced.

Being able to advance a handline with the nozzle fully open is a requisite for successful firefighter rescue. Depending on the nozzle discharge pressure and volume of flow, nozzle reaction forces may be significant. Using hose straps, hose rope tools, or nylon webbing to maintain control of the line, especially 2 1/2-inch line, may be required. Another consideration is the use of two or more lines simultaneously to drive back a heavy volume of fire or to overcome the tremendous heat often encountered in hallways of fire resistive "project" buildings. Drills in advancing handlines also go a long way in increasing physical endurance.

Another interesting drill that develops skill in advancing handlines under difficult conditions while improving physical endurance and mental toughness uses an SCBA confidence course. SCBA confidence courses (sometimes called "mazes") are designed to teach firefighters how to overcome various SCBA emergencies, to develop breathing control for extended time on air, and to cope with feelings of anxiety often experienced while wearing an SCBA facepiece in zero visibility. Preparing an effective RICE, however, requires adding another dimension to this training--advancing a charged handline through the course with obscured visibility. Either covered face- pieces or training "smoke" can be used. Advancing both 1 3/4- inch (or two-inch) and 2 1/2-inch hose should be practiced. In addition to promoting SCBA confidence, it develops the teamwork and discipline necessary for successful firefighter rescue. And it represents many of the difficulties that will be encountered when advancing a hand-line through breached wall openings, over piles of collapse rubble, and through void spaces--all of which may be required to save firefighter lives.

If your department does not have an SCBA confidence course at its disposal, other options exist. One is to construct a temporary course in a parking lot, on the apparatus floor, or in the fire station basement using a few easily constructed portable props in conjunction with three or four sections of metal or plastic drainage pipe. Wooden props representing window openings, restricted passageways, and floor/roof joists can be constructed inexpensively and quickly. Drainage pipe of two different diameters (24 inches and 18 inches) can be used to simulate voids and can even be angled up or down slightly for an increased challenge. Sturdy tables turned on their sides can be used to simulate hallways with bends and turns. Bags of floor absorbent or drums filled with water can be used to anchor the props and prevent movement. Chairs and other furniture can be placed in the path of the advancing handline for still more difficulty. The course configuration is easily changed, keeping it fresh; and by adding simulated fireground noises (yelling, extensive portable radio traffic, sirens, running power saws, glass breaking), the experience takes on a whole new dimension as the firefighters try to get their jobs done while contending with reduced communications and increased emotional stress.

Another option is to use local playground equipment. I learned of this highly creative technique from my good friend Dave McGrail, a captain in the Denver (CO) Fire Department. Many playgrounds today feature equipment consisting of various interconnected tubes, tunnels, slides, platforms, bridges, and so on. Captain McGrail notes that this equipment makes an excellent substitute for a dedicated SCBA confidence course and also provides experience in negotiating confined spaces. Due to the damage potential posed by SCBA cylinders, it may be necessary to dispense with them and simply use covered face pieces. Training at night helps to ensure that the playground will be available and adds the element of diminished visibility. It is probably wise to gain permission from the local parks authority or school board before commandeering the equipment. You never know what additional benefits a good working relationship may accrue.

Training in standpipe operations should also be conducted, particularly in alternative augmentation tactics and the use of 2 1/2-inch handlines for fire attack. As mentioned above, advancing two handlines (specifically 2 1/2-inch handlines) side by side in a narrow hallway may be needed for firefighter rescue and must be practiced. Other drills and training should concentrate on solving water-supply problems, including providing an emergency water relay and replacing burst lengths of hose. All members of the RICE should know how to position the engine apparatus at a hydrant, properly test and flush the hydrant, place the apparatus into "pump," prime the pump, supply booster tank water, and perform a smooth changeover from booster tank water to hydrant water.

In addition to being skilled in all aspects of engine company operations, members of the RICE should be proficient in the use of portable ladders and forcible entry tools. Drills should also be conducted in search techniques, the use of search/guide ropes, elevator emergencies, and operating ladder company apparatus. The RICE chauffeur in particular should know how to operate various types of aerial devices should it becomes necessary to rescue a firefighter trapped in an untenable position. Lastly, all members of the RICE should be equipped with portable radios and be well versed in emergency communications. The importance of listening to the radio for indications of water supply problems, requests for additional assistance, reports on fire extension, MAYDAY messages from lost or trapped firefighters, warnings about collapse hazards, and other fireground developments cannot be overstated.

TOOLS AND EQUIPMENT

The tools of the RICE are very basic: hose, nozzles, and large-caliber (master) stream devices. On occasion, the RICE may need portable ladders, forcible entry tools, and search/guide ropes to complete its assignment. If portable ladders haven`t been placed in strategic locations by the RIT/FAST, the RICE may have to do it. Usually, search/guide ropes will have been previously deployed, and the RICE will simply follow them as necessary. Particularly when elevators are used, the RICE should bring a set of forcible entry tools (flathead ax and halligan or sledgehammer) should self-rescue from a stalled elevator car be necessary. A compact hydraulic forcible entry tool can also be of great benefit. It goes without saying that members of the RICE must wear all assigned personal protective equipment, including hoods and SCBA. Each member should also carry a personal handlight and three or four door chocks. At high-rise operations, each member should bring a spare SCBA cylinder.

SUPPLY LINES AND HANDLINES

The RICE may be required to deploy emergency supply lines and handlines. Large-diameter supply hose should be used if possible, but the effectiveness of emergency water supply tactics will be limited by the size of hose carried on the RICE apparatus and other engines operating at the fire. In situations where large-diameter hose (LDH--3 1/2 inches and larger) is mixed with smaller supply hose, fittings and/or adapters will be necessary. This is an important consideration when it becomes necessary to establish immediately an emergency water supply using LDH and the engine being supplied is not equipped for it.

Handline availability may also pose problems. Many engines carry only three or four hundred feet of 1 3/4-inch (or two-inch) hose. As an example, an engine apparatus is operating near the fire building. It is equipped with two crosslay hosebeds, each containing a 150-foot, 1 3/4-inch preconnected handline. Both lines are in operation, and there is no additional 1 3/4-inch hose and no 2 1/2-inch hose available for emergency use. Although the solution seems straightforward--simply stretch a line from another engine--it may not always be possible to do. Other nearby engines may also be stripped of hose. There may not be another engine close by because of street conditions, snow piles, frozen hydrants, and the like. Likewise, stretching from the dedicated RICE apparatus may be impractical because of the distance involved.

It may be necessary for the RICE to bring folded lengths of hose to a point close to the fire building for connection to an engine operating nearby. It is vitally important to contact the chauffeur of this apparatus to ensure that he has sufficient water available to supply the line and is aware of its length, diameter, and the type of nozzle in use. Squad companies in Chicago, although not equipped with engine apparatus, carry folded 1 3/4-inch hose for deployment in emergency situations. In New York City, each engine and ladder company is required to carry three folded lengths of 1 3/4-inch hose and three folded lengths of 2 1/2-inch hose. Many departments use 1 3/4-inch and two-inch hose bundled or carried in bags for use from manifold or wye-type appliances. This hose can also be used during emergencies involving trapped firefighters. Handlines carried by the RICE should be compatible with other handlines in use on the fireground. In other words, couplings should be the same thread type and size, or fittings and adapters must be readily available. This can be an important consideration when the RICE is from another fire department responding on mutual aid. Additional thoughts and considerations on emergency handline use are provided below in the section entitled "Fireground Operations."

NOZZLE SELECTION

Solid-stream nozzles are recommended because of their low operating pressures; hard-hitting streams; reduced nozzle reaction; and the fact they do not clog, freeze, or damage easily. This does not rule out the use of fog tips under certain conditions, however. Fog nozzles, for example, may be required for gas and vapor dispersal or where energized electrical equipment is in proximity to firefighter rescue efforts. If fog nozzles are required, low-pressure types may be best--particularly when used in conjunction with a breakaway nozzle system that also incorporates a solid-stream tip. A sound policy for the RICE is to use its own nozzles whenever possible. This permits the team to employ the nozzle size and type best suited for the situation. In addition, the RICE will be intimately familiar with its own equipment, and there should be no question about the mechanical condition of any nozzle used in firefighter rescue. The use of large-caliber streams in firefighter rescue is discussed below.

Size-up for the RICE varies in scope and focus from that of earlier-arriving companies. Since the objective of the RICE is to safeguard firefighter lives, specific attention should be given to the following seven critical areas: construction, occupancy, height and area, exposures, location and extent of fire, water supply, and auxiliary (installed) fire protection systems or features. Let`s examine each in more detail by listing some of the many questions that must be answered during the rapid intervention engine size-up.

Construction. What is the construction of the fire building? How old is it? Is it "lightweight" with early collapse potential? Are there void spaces? Is rapid fire spread to be anticipated? Has it been renovated?

Occupancy. What is the type of occupancy? Is it a single or mixed occupancy? What are the hazards posed by the occupancy--storage hazards, process hazards, for example? Should large, open areas be anticipated? Should heavy fire loads be anticipated?

Area/height. How large is the fire building? Are standpipe operations needed? Is elevator usage needed? Is the fire area within reach of aerial ladders or elevating platforms? Are long, complex hand stretches involved? Are there multiple access points to the fire area? Are there roof setbacks that will aid in or interfere with operations? Will the building`s size necessitate additional rapid intervention engine companies?

Exposures. Is extension of fire possible or even likely? What are the construction and occupancy of each exposure? Are the exposure buildings adjacent to the fire building, or are they separated by streets, alleys, or shafts? Are the exposure buildings the same height as the fire building? Do the exposures provide vantage points for streams or access points for firefighter rescue?

Location and extent of fire. Has the main body of fire been located? What did first-alarm companies report regarding fire location and severity? What fire conditions are observed on arrival? Based on the construction, what are the potential avenues of fire spread? Is autoexposure a problem? Is collapse likely?

Water supply. What type of water supply is in use--booster tank, hydrant, static source? Is a relay operation in progress? What size supply hose/hydrant connection is in use? Has water supply redundancy been provided (at least two separate water sources)? Do vandalized hydrants present a problem? Are hydrants frozen? Have apparatus tires, outriggers, or tormentors been inadvertently placed on hoselines? Do radio reports indicate problems with hydrants or poor pressures?

Auxiliary fire protection systems. If the fire building is protected by sprinklers, is the siamese connection supplied? If a standpipe system is present, is the siamese connection supplied? Are alternative augmentation tactics needed? If a lower-floor hose outlet is being used for supply, is the valve fully open? Are pressure-regulating devices (PRDs) installed on the standpipe or sprinkler system? Can the PRDs be removed, defeated, or readjusted? Do radio reports indicate poor nozzle pressures or weak sprinkler performance in the main fire area? Do exposure buildings have standpipe or sprinkler systems that may need to be supplied?

Although size-up is usually thought to begin with the receipt of the alarm, it actually starts much earlier--with prefire planning. Since the RICE will rarely have the same level of knowledge about the fire building as the first-due companies, obtaining prefire planning information is vital. FDNY uses the Critical Information Dispatch System (CIDS). Fire companies are encouraged to submit CIDS information on any building or occupancy that poses unusual hazards or potential operational problems. When a fire is reported in a building or occupancy included in the CIDS, the computer-assisted dispatch system automatically provides the most recent information available. In addition, if a fire is reported in any building within three street numbers on either side of a building included in the CIDS program, the CIDS information is automatically provided. Information in hard copy form is printed on dispatch from quarters and is also received by way of the mobile printers on each apparatus. The first-due battalion chief also can request that the dispatcher broadcast CIDS information.

While responding to an alarm, it is imperative that all members of the RICE monitor the radio, listening for special instructions and reports on the progress of firefighting efforts (or lack thereof). Indications that the fire situation is deteriorating include transmitting additional alarms, placing a recall in effect, and requesting mutual aid. If a separate fireground frequency is used, it must be continuously monitored for indications of problems that might require RIT/FAST intervention. RICE team members must remain constantly alert for MAYDAY and URGENT messages and any other call for help, regardless of its form or source. Once on the scene, a RICE member may have to move away from the cacophony of the fireground to hear radio transmissions more clearly. When monitoring the radio, be attentive; fear and anxiety are easily detectable in the human voice and may be indicative of a very serious predicament.

FIREGROUND OPERATIONS

Prevention Is the Goal

The goal should be to prevent firefighter injuries by identifying and solving fireground problems before firefighters become distressed and rescue efforts are needed. With this in mind, the RICE should pay particular attention to the following key items and include them as part of its ongoing size-up.

On arrival at the scene, the RICE should obtain up-to-date information on the firefighting strategy employed, the location of companies within the fire building (and exposures, if applicable), and any tactical problems experienced by the operating forces. Consult with the FAST company officer regarding his size-up. Problems involving the water supply must be handled first, and a water supply survey should be conducted. Often, the RICE chauffeur can evaluate the water supply situation and help solve any pressing problems at the same time the RICE officer is being briefed by the IC.

Helping to establish an emergency water supply caused by a mechanical breakdown or burst supply hose may be the single most important act the RICE performs. If the water supply situation appears well in hand, the RICE chauffeur (or another designated RICE member) should walk around the fire building (if possible) and gather additional size-up information to aid the RICE should emergency handline deployment be needed. This information should include the following: the location of unused hydrants; alternate building entrances providing access to the fire area; placement of portable, aerial, and tower ladders; locations of fire escapes; changes in building height; and observed fire conditions. Remaining RICE members should stage near the command post or at another strategic location as determined by the RICE officer. In high-rise building fires, the RICE should stage one or two floors below the fire. Ideally, the RIT/FAST will be staged at the same location so both units can be deployed together when an emergency arises.

Members of the RICE should also note the size of handlines in operation and if they are compatible with fire conditions. Al-though many fire departments fail to use 2 1/2-inch hose, some fire situations demand its use. If 1 3/4- or two-inch handlines are having difficulty, the RICE should be prepared to stretch 2 1/2-inch hose if a firefighter rescue is required. Kinks observed should be straightened, and any handline that appears to be struggling should be "lightened up."

Another key size-up issue for the RICE is to determine how much hose will be needed to reach various areas of the fire building should firefighters get into trouble and protective streams be required. If the first-due engine company "stretched short," adding hose will solve the problem. If too much hose is stretched, determine if the line can be shut down and the excess lengths removed. At standpipe operations, check the supply hose feeding the siamese connection. Verify that the intended siamese is being supplied and is functioning properly. Even when the RICE uses an elevator to reach an upper-floor fire, one member should be assigned to walk up the stairs and note if pressure-regulating devices are installed and to ensure that the sectional control (zone) valves are fully open. It is also important for members of the RICE to note the floor, stairway, and apartment numbering system in use and to be aware of changes in occupancy or floor layout from one story to another.

USE OF HANDLINES

When deploying a handline for firefighter rescue, four possible scenarios exist.

-Scenario 1. The RICE uses a handline that is already stretched and charged. This may be necessary to save time or when the firefighters operating the line become injured or deplete their breathing air supplies.

-Scenario 2. A handline is stretched from an engine apparatus operating near the fire building. Communication with the chauffeur/pump operator is vital to ensure that this engine can supply the line properly and there is sufficient hose remaining to reach the point of operation.

-Scenario 3. Folded or bundled hose is carried from the RICE apparatus and connected to an engine closer to the fire building. Once again, communication with the engine company chauffeur is essential.

-Scenario 4. If the other options are not feasible, a line may be stretched directly from the RICE apparatus. If this need is anticipated, the RICE chauffeur should secure a reliable water source and position his apparatus with the rear or main hosebed facing the fire building. This will expedite deployment of an emergency supply line or long handline should it be needed.

For additional considerations and a different point of view on this and other specific fireground operations, see "The RIT/FAST Engine: Operational Guidelines" by Larry Cohen on page 86.

LARGE-CALIBER STREAMS

As mentioned earlier, a Detroit firefighter who had become trapped at a third-floor window was saved by a large-caliber (master) stream directed into the window from an engine mounted deckpipe. An outside stream, be it from a handline or large-caliber stream (LCS) appliance, may be a trapped firefighter`s last chance. Following are some important recommendations for ensuring the safe and effective use of outside streams--particularly LCS--in firefighter rescue operations. Although most of this section is devoted to engine-mounted LCS, it may be necessary for the RICE to quickly deploy a portable LCS; for this reason, preconnected, lightweight models are recommended.

Not long ago, almost all engine apparatus were equipped with 3/4- or one-inch booster hose. It was relatively easy for an engine company chauffeur, alone, to quickly charge the booster line and direct the stream as needed for lifesaving purposes. A fire on the first floor of a five-story tenement in the Bronx caused numerous occupants to flee their apartments. Unable to use the interior stairs because of heavy smoke, they began descending the fire escape but were blocked by heavy fire venting from two first-floor windows. The fast-thinking chauffeur from Engine Company 43 protected them by keeping the fire at bay with his booster line until a portable ladder could be raised to effect their removal. Without his efforts, the fire escape would have grown overcrowded with both smoke-inhalation injuries and burns inevitable as the fire escape turned into a giant barbecue grill. Today, with booster lines installed on fewer and fewer engines, this option is rarely available. The time delay involved with flaking out a length or two of "trash" line (usually 1 3/4-inch hose stored in a trough at the front or side of the apparatus) may be too great when a civilian or firefighter is faced with burning to death or jumping. The solution is to use a prepiped (or otherwise preconnected) engine-mounted LCS, thus providing much higher flows and greater stream reach than any handline.

Most prepiped LCS (sometimes referred to as deckpipes or wagon pipes) are controlled solely from the pump operator`s panel. If the chauffeur charges the deckpipe without another firefighter available to direct the stream, its effectiveness as a lifesaving tool is lost. Should a deckpipe operation commence using booster tank water, the tank will be depleted in a very short time and most, if not all, the water will be wasted as the chauffeur scrambles atop the apparatus to control the appliance. The solution is to fit the deckpipe with a shutoff valve, allowing the chauffeur (or another firefighter) to charge the deckpipe at any time; he can then climb atop the apparatus to accurately direct and control the stream. While a ball-type nozzle shutoff can be used, it is better to install a 2 1/2-inch gate valve on the appliance side of the stream shaper. This facilitates easier opening and closing under the high operating pressures typical of LCS and reduces the potential for a destructive water hammer should a ball-type shutoff be closed too abruptly. Whenever an outside stream--particularly an LCS with its tremendous air movement and hydraulic force--is employed in rescue operations, a radio message must warn firefighters inside the fire building so they can seek an area of refuge.

MAKE A RICE POLICY

A rapid intervention engine company should be incorporated into every RIT/ FAST policy. Successful firefighter rescue requires the ability to quickly place lifesaving fire streams into service, and a company (or companies) must be dedicated to this task. Especially in this era of bare-bones staffing, we must ensure resources are available to "save our own." When a fellow firefighter is trapped, the risk/benefit calculation must be modified, and the risks taken may be greater than usual. The presence of a well-trained RICE helps lessen these risks and may allow an otherwise impossible rescue attempt to succeed. Our trapped brothers and sisters deserve nothing less.

Fire Engineering
August 1999

STANDPIPE OPERATIONS CLARIFICATION

BY ANDREW A. FREDERICKS

In "Standpipe System Operations: The Standpipe Kit" (February 1999), I mentioned that a 20-inch pipe wrench is better than the standard 18-inch wrench. Unfortunately, I didn`t do enough research, and for this I apologize. Although a plumbing authority informed me that 20-inch pipe wrenches are available, I haven`t found a manufacturer that makes them. Standard lengths include six, eight, 10, 12, 14, 18, 24, and 36 inches. Some firms manufacture 25-inch wrenches, and some offer 48-inch monster wrenches. Perhaps my contact was confusing another type of wrench (adjustable, for example, which are available in 20-inch lengths) with a pipe wrench. Or maybe some obscure company (overseas, perhaps) does manufacture a 20-inch pipe wrench. If you are aware of such a company, please let me know.

Why all the fuss? As I stated previously, the clear hook jaw opening on an 18-inch pipe wrench is at its maximum when the wrench must be used like a spanner to free a stuck cap, PRD, or reducer fitting. A wrench with a clear hook jaw opening greater than that afforded by an 18-inch pipe wrench (in the books as 2 1/2 inches--actually more) will eliminate the possibility of the hook jaw assembly`s falling apart in the middle of an operation.

Another solution is to use a 24-inch pipe wrench with a cut-down handle. Because steel is so heavy, an aluminum wrench is virtually a necessity but also rather expensive. I asked a technical support representative for a large and well-respected manufacturer if the hook jaw on a 24-inch pipe wrench could be swapped with the hook jaw of an 18-inch wrench. Alas, without retooling, it is not possible. My plea to tool and equipment manufacturers: Construct a lightweight pipe wrench with a clear hook jaw opening of at least three inches and a handle length that does not exceed 18 inches.

There are also some corrections and clarifications to my article "Engine Company Support of RIT/FAST Operations" (April 1999). On page 85, I discussed the use of metal or plastic drainage pipe in constructing an SCBA confidence course. Pipe smaller than 24 inches in diameter is not necessary. Firefighters dragging a charged handline with them will find the restriction posed by 24-inch pipe sufficiently challenging.

On page 88, clarification of the tool selection for elevator usage is required.

A set of forcible entry tools must be brought aboard each elevator car used by fire service personnel. This set of tools may be the traditional irons (flathead ax and halligan) or a sledgehammer and halligan. Either way, both a striking tool and a prying tool should be available.

On page 89, the second sentence of the photo caption should read (correction in italics), "In addition, RICE members--particularly the chauffeur--should be able to operate each of the aerial ladder, tower ladder, or ladder tower apparatus they encounter should a firefighter need to be rescued from an untenable position."

Fire Engineering
October 1999

Y2K: ARE YOU PREPARED FOR HIDDEN HAZARDS?

ANDREW A. FREDERICKS

As the year 2000 approaches, fire departments are faced with many questions: Will in-house computer glitches affect physical plant functions (heating, lighting, security), communications, record keeping, and payroll? Will external computer glitches affect the performance of fire alarm systems and the delivery of water, electricity, phone service, and natural gas? Will power outages affect response times, workload, and the ability of personnel to travel to work? Will terrorists seize the opportunity to advance their agendas? Although proactive fire departments have developed strategies for coping with these issues, there may be lurking other, more insidious, problems, the ramifications of which may be felt for many years. Let me explain.

This past July, while I was training recruit firefighters at the New York State Academy of Fire Science, a fellow instructor and deputy chief in the Olean (NY) Fire Department related to me some of the questions citizens are asking his department concerning Y2K. Questions such as the following have been posed to Olean Fire Department code enforcement personnel:

"Can I wire my new gasoline-powered generator into my home`s electric panel box?"

"How much gasoline can I store in my basement? I just purchased a 300-gallon tank."

"How much propane can I store in my basement? I just purchased a regulator/ adapter to convert my natural gas furnace to LPG."

"Do I need a building permit to construct an underground shelter?"

These questions should not only throw up red flags--they require an immediate and aggressive response. As the year 2000 nears and the chorus of doomsday prophets grows louder, it must be assumed that more and more individuals and businesses will attempt to cope with possible outages and shortages by stockpiling water, food, and fuel. It is this latter category--large quantities of diesel and kerosene and highly volatile fuels such as gasoline and LPG--that are of most concern to fire departments. The danger is obvious in the short term, but stockpiles of these materials are like unexploded bombs that kill and maim long after the war is over. Unused gasoline stored in a basement may someday injure or kill firefighters advancing a handline. A long forgotten LPG cylinder may undergo a BLEVE (boiling-liquid, expanding-vapor explosion) during a fire and fatally injure dozens of firefighters. A tank containing several hundred gallons of kerosene may plummet through a fire-weakened floor, killing firefighters operating below.

PREPLANNING IS KEY

What should the response of fire departments be? Although all incidents such as those described above cannot be prevented, certain steps can be taken to help ensure the safety of the public and firefighters alike. An aggressive public education campaign should be mounted immediately. The Olean Fire Department has taken ads in the local newspaper and is using radio announcements to warn of the dangers posed by the storage of gasoline and LPG and the illegal modification of heating and electrical equipment. Newspaper reporters have also been invited to attend meetings of Olean`s disaster preparedness committee to report objectively on the seriousness of this threat to public health and safety. Other public education options include cable TV advertising and direct mailings to homes and businesses. Certainly, this year`s Fire Prevention Week activities should include Y2K issues.

Problems involving commercial occupancies should be discovered during normal code enforcement activities, but most of these dangers are likely to exist in private residences. Firefighters should take note of anything unusual during everyday response to minor fires, emergencies, and EMS incidents that bring them into people`s homes. It may also be beneficial to meet with local hardware store owners, gasoline station managers, and heating oil and propane dealers to educate them about these dangers and to determine if any oddball requests or large-scale purchases have been made in the past several months. Enlisting the assistance of other municipal government agencies--the building inspector`s office, the police department, and the sanitation department--is also recommended. Any unusual incidents experienced by these agencies should be noted and followed up as appropriate.

Obviously, public education alone will not solve the entire problem. The Y2K danger is real, and we should take nothing for granted. Police departments have had success with "guns for cash" or "guns for toys" exchanges; perhaps fire departments could institute a similar program in which the public would be asked to surrender excess quantities of gasoline and propane in exchange for something else. Of course, complete immunity from all fines and penalties must be granted, and the program should be well publicized. It may be necessary for the local haz-mat team or private vendors to collect and transport the materials and containers because of the risks involved.

TIPS FOR OPERATIONAL SAFETY

Despite these efforts, dangers posed by Y2K storage will persist. We must not let our guard down. If we do, a seemingly "routine" fire operation might suddenly change into a catastrophic event. Here are some tips when operating at fires and emergencies to help keep everyone safe:

•*Always wear all personal protective equipment and SCBA.*
•*Always carry a powerful handlight and a portable radio.*
•*Note anything that seems different, unusual, or out of place, particularly for the type of occupancy involved.*
•*Be aware of uncharacteristic odors and smoke colors when operating at fires.*

•*Be alert to illegal wiring arrangements and heating system modifications.*
•*Look out for drums, tanks, and compressed gas cylinders, particularly in garages, basements, and cellars.*
•*Look for ramps leading to below-grade areas, and be cognizant of overloaded floors.*
•*Above all, get on the radio and report your findings.*

Your information could be the key that leads to a change in firefighting strategy that ultimately will save firefighters` lives.

Fire Engineering
February 2000

LITTLE DROPS OF WATER: 50 YEARS LATER, PART 1

BY ANDREW A. FREDERICKS

As we approach the new millennium (remember, the new millennium begins January 1, 2001), a debate still rages over the use of water fog in interior fire attack. This debate has become more lively in recent years because of the proliferation of on-line computer users in the fire service and the ever expanding role of the internet as a forum in which to present new ideas or support old ones. This article begins with a brief history of the use of fog streams in structure fire attack. I obtained much of this information by studying the original articles, books, and papers written by three men generally considered to be the fathers of fog firefighting in America-Lloyd Layman, Keith Royer, and Floyd W. "Bill" Nelson.

FOG NOZZLE HISTORY
Fog nozzles and spray streams have been around for almost 150 years. The first United States patent for a fog nozzle was granted to Dr. John Oyston in 1863. During the late 1800s and continuing through the turn of the century, various articles appeared in fire service literature extolling the merits of spray streams. One of the earliest such articles, entitled "Extinguishing Fires," was written by Oyston himself. It was originally published in Oyston's local newspaper but was reprinted in the March 16, 1878, edition of the National Fireman's Journal (known today as Fire Engineering). Significant research in fire behavior and the use of spray streams for interior fire attack began in the United Kingdom and several western European countries during the 1920s-research that continues to this day. In the mid-1930s, Elkhart Brass introduced the first production periphery jet fog nozzle to the American fire service. Known as the "Mystery" nozzle, it was based on a nozzle designed by the Mystery Nozzle Company in Hamburg, Germany, some years before. The United States Navy and Coast Guard used a combination fog/solid-stream nozzle during World War II, although its exact date of issue may predate the war by several years. Manufactured by the Rockwood Sprinkler Company, and known as an "all-purpose" nozzle, it was available for both 1 1/2-inch and 2 1/2-inch hose and had a three-position shutoff that could produce both an impinging jet fog stream and a solid fire stream. It could also be fitted with a variety of extension applicators. It is still in limited use today by the Navy as well as several fire departments.

Despite their long history, fog nozzles were virtually unknown through the first half of the 20th century. The solid fire stream stood for decades as the unchallenged weapon of choice for structure fire attack by America's fire departments. Then, in 1950, it all changed. In the February 1945 issue of Fire Engineering, an article described the results of experimental shipboard fires conducted at the U.S. Coast Guard Firefighting School at Fort McHenry in Baltimore, Maryland. Entitled "Coast Guard Conducts Tests on Ship Engine Room Fires," it explained both the testing process and various techniques developed for combating fuel oil fires in the confined machinery spaces of large ships using water fog (a decommissioned Liberty ship was used as the test vessel). While the article is interesting, its impact on structure firefighting tactics is not considered significant. It wasn't until five years later that the importance of the Coast Guard tests would begin to be understood. What happened in 1950 that so radically changed fire suppression tactics? The late Chief Lloyd Layman of Parkersburg, West Virginia, presented a paper entitled "Little Drops of Water" at the Fire Department Instructors Conference (FDIC) in Memphis, Tennessee, and in the process stood the fire service on its collective head. In his paper, Layman introduced what he termed the indirect method of attack to suppress interior building fires using the tremendous heat-absorbing properties of expanding and condensing steam, produced in great quantities by fog (spray) streams. Most of the theory and methodology of indirect fire attack was based on the Coast Guard experiments (Layman was in charge of the Coast Guard's wartime firefighting school at Fort McHenry), as well as additional testing conducted jointly by the U.S. Navy and other agencies in San Francisco under the project name "Operation Phobos." Layman continued his experiments after he returned to his position as fire chief in Parkersburg, where he began in earnest applying the indirect method of attack to building fires. Layman explained his theories and methodologies in great detail in two books published by the National Fire Protection Association (NFPA): Attacking and Extinguishing Interior Fires (1952) and Fire Fighting Tactics (1953).

To objectively evaluate Layman's approach, we must be familiar with both the underlying theories and the specific techniques advanced in his books and other writings. First and foremost, the "indirect method of attack" is not an interior fire attack operation. Rather, Layman's methodology emphasizes that the fog stream should be remotely injected into the fire compartment at the highest possible level with the nozzle held in a fixed position. The following quote from Attacking and Extinguishing Interior Fires could not be any more explicit in warning of the dangers personnel face from the large quantities of steam created during an indirect attack: "An indirect attack should always be made from positions that will enable personnel to avoid injuries from super-heated smoke and live steam." Layman continued by stating that "if possible and practical, an indirect attack should be made from positions outside the involved building." In other words, he advocated that fog streams be directed through window openings because of the voluminous quantities of steam created within the fire building. Layman went so far as to discourage the use of doorways for fog application, as the outflow of scalding steam would be extremely debilitating to the nozzleman. In addition to remote injection of the water fog, there are two other requirements for success when using the indirect method. First, the ceiling temperature within the fire compartment must be at least 1,000°F to ensure ready and efficient conversion of the fog spray to steam. When a fire is in the first or early second phase of development, the direct method of attack with timely and adequate ventilation is preferred. Second, the fire compartment (building) must be well sealed to prevent premature leakage of valuable steam to the outside. A well ventilated fire building on the fire department's arrival warrants a direct attack, since the indirect method is only effective if the fire building remains sealed with doors and windows intact. Layman also stated that "where the major area of involvement is on upper floors, it may be possible and practical to attack from an interior stairway below the involved floor." He continued by warning that "the nozzleman may have to discontinue the attack temporarily to avoid the downward movement of heated smoke and steam."

THE NATIONAL EXPLORATORY COMMITTEE

Shortly after "Little Drops of Water" was published, the Exploratory Committee on the Application of Water was formed to evaluate fire extinguishment techniques using fog and spray streams. Perhaps better known as the National Exploratory Committee or, more simply, the National Committee, it was comprised of fire chiefs, training officers, and members of fire insurance rating organizations and was created "to bring some badly needed light to a very foggy subject." Beginning in 1951, the National Committee began conducting instrumented live fire tests to collect hard data on the growth and behavior of interior fires and the most effective methods of attacking these fires using water or, more specifically, water fog. Throughout the 1950s, tests were conducted under the auspices of the National Committee and independently by various fire departments, as well as the National Board of Fire Underwriters (NBFU), Underwriters Laboratories, and other research institutions. It was the research work of two individuals, however, that has had the most long-standing impact on the fire service.

Beginning in 1951 and continuing for more than three decades, Keith Royer and the late Floyd W. "Bill" Nelson headed the firemanship training program at Iowa State University's Engineering Extension. With the resources available to them at Iowa State, as well as through their membership on the National Committee, they helped collect and analyze data from literally hundreds of experimental fires. Their efforts provided the nation's fire service with a much better understanding of interior fire behavior and the mechanisms of fire extinguishment using water. Among their many contributions, Royer and Nelson developed a formula for estimating, with a high degree of accuracy, the amount of water required to control an interior fire based on the following: a) the amount of heat liberated by common fuel materials burning in ordinary air within a compartment, b) the extinguishing (heat absorbing) capacity of water, and c) the cubic foot volume of the fire compartment. In the "critical rate of flow" formula, as it came to be known, Royer and Nelson determined that the amount of water (expressed in gallons per minute) needed to control (not completely extinguish) a fire in the largest open space within a structure can be determined by dividing the cubic foot volume of the space by 100. Royer and Nelson explained the formula and its scientific basis in Engineering Extension Service Pamphlet #18 "Water for Fire Fighting-Rate of- Flow Formula" (1959, Iowa State University). They also introduced the fire service to a fire extinguishment technique they called the "combination method of attack."

THE COMBINATION ATTACK

Several factors must be considered to execute a successful combination attack. Chief among them is that, like the indirect method of attack, the combination attack was designed primarily for exterior application of the water. Remember, turnout clothing in use during the 1950s and 1960s lacked the thermal protective qualities of modern fabrics. In addition, many fire departments had few, if any, self-contained breathing masks available. These facts, coupled with the large amounts of steam produced during a combination attack, necessitated an exterior application of water fog whenever possible. If a fire had to be attacked from an adjoining room or hallway, or if multiple rooms were involved in fire and exterior application of the stream were impractical, Royer and Nelson cautioned that a very narrow fog stream should be used to begin the attack. The narrowest fog stream is, of course, a straight stream, which would cause the least disruption to the thermal balance.

In addition to Engineering Extension Service Pamphlet #18, Royer and Nelson's discoveries were published in two Fire Engineering articles. "Water for Fog Fire Fighting-How Much and How to Apply It!" (August 1959) described the combination attack but did not specifically identify it. "Using Water as an Extinguishing Agent: Part 2-Utilizing Heat" (November 1962) contrasted and explained in some detail the various methods of structure fire attack-direct, indirect, and combination. But three films produced by Iowa State University-The Nozzleman (1959); Coordinated Fire Attack (1960); and, to a lesser extent, Where's the Water? (1971) introduced the vast majority of firefighters to the combination method of attack. To initiate a combination attack, first select an opening(s) for stream application. Adjust the size of the fog pattern (discharge cone) based on the approximate dimensions of the fire compartment. Next, thrust the nozzle about an arm's length through the opening into the fire compartment and rotate it as violently as possible with a clockwise motion.

Speaking to the lack of personal protective equipment during the 1950s and 1960s, Royer and Nelson noted that "to do this the nozzleman must have glove, helmet and protective coat." During their many experimental fires, Royer and Nelson discovered that a clockwise rotation of the fog nozzle was required to drive heat, smoke, and flame away from the nozzleman. The objective of the combination attack is to "roll" the stream around the perimeter of the room, cooling the walls, ceiling, and floor with the outer edge of the stream while the inner portion of the stream cools hot gases being produced by the fire. Striking the heated ceiling, walls, and fuel materials produces the maximum amount of steam within the shortest period of time. If the rate of flow is sufficient and the water distribution is efficient, the main body of fire should be "blacked out" after no more than 15 to 30 seconds of stream application. By shutting the nozzle down promptly after the fire darkens, enough heat will remain within the fire area to permit the smoke to lift and afford the overhaul crews improved visibility and lower humidity. Royer and Nelson were very emphatic in their writings when discussing the importance of avoiding "overcooling" and managing the thermal balance to aid in ventilation and overhaul.

MISAPPLICATION AND CONFUSION

Misapplication of Royer and Nelson's methods began almost immediately. For example, the concept of managing heat-using the thermal balance within the fire area to advantage-was quickly lost on many practitioners of the combination attack. In a telephone conversation I had with Royer a few years ago, he said he was very surprised when he first learned how commonly firefighters attempting a combination attack were beset with poor visibility and often suffered steam burns. I believe the misapplication and confusion is attributable to several causes. One involves improvements in firefighter protective clothing and SCBA during the 1960s and 1970s, prompting more and more fire departments to attempt interior fire attack operations. David Fornell, author of Fire Stream Management Handbook, believes that since the tactics depicted in the The Nozzleman and Coordinated Fire Attack utilized fog streams exclusively, many in the fire service became convinced this was now the only type of stream suitable for structure fire attack. Fornell described what he terms the "interior, indirect attack." Like the misunderstanding surrounding the combination attack, Layman's indirect attack was also widely misunderstood and improperly applied. Layman, himself, contributed to the confusion by including a single paragraph in Attacking and Extinguishing Interior Fires that stated a "direct" attack with fog nozzles may sometimes be indicated and that a 30-degree fog pattern directed at an upward angle is the preferred method. Unfortunately, he made no mention of the role of ventilation when employing this technique; and warnings about the dangers of steam burns to the nozzle crew, prominent earlier in his book, are conspicuously absent here. Fornell sums it up best in Fire Stream Management Handbook: "The interior indirect, or combination, attack as practiced by a large percentage of the fire service today was invented by the fire service itself to compensate for problems encountered employing techniques based on earlier self invented principles. Nowhere in his writing did Chief Layman present scientific arguments that advocated spraying water over firefighters' heads in a fire situation in order to create steam bath conditions. On the contrary, he said firefighters would be enveloped in a hurricane of water converting to steam."

WATER FOG AND LIFE SAFETY

While many an interior fire attack has failed when the nozzle team had to quickly retreat because of steam burns, the full impact of live steam on civilians trapped within the fire building remains uncertain. Studies indicate that when heated air becomes saturated with moisture, the opportunity for and severity of burn injuries rise dramatically. The Fire Protection Handbook (17th Edition), in discussing the impact of heat on life safety, states that "the effects of exposure to heated air are greatly augmented by the presence of moisture in the fire atmosphere." Studies by the National Research Council of Canada indicate that 149 degrees celsius (300.2 degrees fahrenheit) is the maximum survivable breathing air temperature and that "a temperature this high can be endured for only a short period and not at all in the presence of moisture." Insofar as Royer and Nelson's writings are concerned, there is no mention of the impact of steam on trapped occupants. In Fire Stream Management Handbook, Fornell writes in reference to the articles and films of Royer and Nelson: "In viewing the films and reading the results of their research, it must be noted that their tactics advocated application of water from outside the fire building. Though they did discuss interior application, the first priority in the Iowa method was to knock down visible fire before making entry. Mr. Royer says their testing did not address the problem of fire spread caused by applying streams from the outside of the building. The subject of life safety or the effects of steam on trapped victims was never addressed in the three films." In Attacking and Extinguishing Interior Fires, Layman states: "In answer to the question regarding the effect on occupants of steam from fog application, we can only state that we have not heard of any adverse effects." Layman continues: "Contrariwise, the much more rapid flame suppression with indirect application makes it possible to reach endangered persons more quickly so as to be able to remove them to safety and render aid as necessary." This statement, which appears in the third paragraph on the third to last page of a 148-page book, does not specifically address the impact of steam exposure on trapped occupants. It simply implies that indirect attack may knock down the fire faster than other methods and allow quicker removal of any victims.

LAYMAN BEFORE FOG

Few members of the fire service know that long before "fog mania" swept the nation and confused a generation of firefighters as to proper structure fire attack methods, Layman wrote a book emphasizing the importance of the direct method of fire attack. Published in 1940, Fundamentals of Fire Fighting Tactics examines eight basic fireground functions that together comprise a tactical plan for the successful attack, control, and extinguishment of fires in buildings. I will limit this discussion to Chapter VI, simply called, "Extinguish Fire." Layman stated that "the most important factors in extinguishing a fire within a building are first-to locate the main body of fire, second-to apply [the] necessary amount of water or other extinguishing agent on the BASE OF THE FIRE." (The capitalization is Layman's emphasis.) Layman continued by providing a list of nine "principles and suggestions" for extinguishing interior fires. In examining this list, numbers three through seven are particularly interesting, especially in light of Layman's later writings. They are reprinted below:

-If possible, attack the main body of fire so as not to drive heat and flames into uninvolved sections of the building.

-Use streams of sufficient size to provide necessary volume of water, but avoid using a one inch stream where a quarter-inch stream would be sufficient.

-Direct the stream to the base of the fire.

-As soon as all visible flames have been killed, close nozzle; if the fire flares up, open nozzle again, but close it when visible flames have been killed.

-Don't direct streams into smoke-filled rooms. Wait until the fire has been located and the stream can be directed into the burning material.

These five principles are so sound and basic; they are as true today as they were when they were written 60 years ago.

THE DEBATE CONTINUES

In the past 15 years or so, we have witnessed a resurgence in the use of solid streams, or at least straight streams, as many firefighters and fire officers have realized that using fog streams inside the fire building is rarely a wise and productive action. The fire service has taken many years and detoured down many dead-end paths (remember high-pressure fog?) in reaching this conclusion. Many within our ranks still lack a complete understanding of the tactics and techniques developed by Layman and the Iowa State researchers. Others are just plain stubborn and refuse to face the truth. Sadly, unnecessary firefighter burn injuries and excessive property damage will continue as net results of this situation. Recently, researchers in the United Kingdom and Sweden introduced the American fire service to the idea of "offensive" water fog application. This has generated still more confusion, and the debate over "fog" vs. "solid" shows no signs of abating. Part 2 of this article will analyze offensive fog techniques as well as Class A foams and other "advancements" in our ability to control and extinguish interior fires.

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March 2000

LITTLE DROPS OF WATER: 50 YEARS LATER, PART 2

BY ANDREW A. FREDERICKS

As we learned in Part 1 (February 2000 Issue), the “indirect” and “combination” methods have been largely misunderstood and widely misapplied. By the 1980s, many fire departments, disillusioned by years filled with failed fire control efforts and painful burn injuries, abandoned the use of fog streams for interior firefighting. Some returned to solid stream nozzles that for years had been relegated to dusty shelves in fire station closets. Many others, heavily invested in fog nozzle hardware, instructed their firefighters to employ only straight streams during interior fire attack.

THE MODERN ENVIRONMENT

Today’s fireground environment is far more hostile and unpredictable than it was in the 1950s. One reason is the endlessly expanding role of plastics. Plastics, being derived from petrochemicals (hydrocarbons), burn vigorously given the opportunity and produce large quantities of dark, acrid smoke. Plastics may be found partially or wholly in furniture, window treatments, clothing, toys, sporting goods, floor coverings, wall coverings, countertops, electronics, major appliances, housewares, and hundreds of other consumer products. Significant amounts of plastic are used in building construction. Plastics are often expanded for use in seat cushions, pillows, mattresses, insulation, and packaging materials. Expanded plastics (also known as cellular or foamed plastics) may pose a significant fire hazard. “Some reports tell of fast-spreading, high-intensity fires and voluminous smoke production”. Many plastics used in interior furnishings and finishes are “thermoplastics.” Thermoplastics, unlike thermosetting plastics (or more simply thermosets), produce flaming drips when they burn, which may flow and extend fire to uninvolved fuels. Pools of burning liquid plastic generate additional quantities of smoke and flammable gases and make firefighting more hazardous. One firefighter from a busy engine company in the South Bronx inadvertently knelt on a molten plastic TV cabinet and was severely burned. He had to undergo multiple skin grafts and extensive rehabilitation.

Buildings today further contribute to the hazard because they are often well sealed and limit the opportunity for heat loss. A fire growing within a compartment (room) that loses little heat to the outside will become hotter faster and build up large quantities of toxic gases more quickly than a fire in a less insulated room of similar size. The widespread installation of wall and attic insulation, draft barriers, membrane roofing systems, and energy-efficient windows in new construction and renovations plays a significant role in the subtle (and not so subtle) changes in interior fire behavior that have been observed during the past two decades. Probably the most significant factor is the energy-efficient window (EEW). These windows, often called thermal pane windows, do not fail as readily as older, single-glazed windows. As a result, the highly heated, sooty smoke characteristic of today's plastic filled fire environment, since it cannot escape, will quickly fill the fire occupancy. Firefighters today routinely encounter brutal head conditions and, more and more frequently, a complete absence of visible fire. This phenomenon has been termed "black fire."

BLACK FIRE

A firefighter from a busy Bronx, New York, engine company related to me the following story. He was assigned as the nozzleman for the tour. His company arrived first due at a fire in a renovated multiple dwelling. On entering the fire apartment with a charged handline, he noted that heat conditions were severe and the apartment was filled with dense smoke. Unable to quickly locate the seat of the fire and anticipating that flashover was imminent, his officer ordered him to open the nozzle. As he directed the stream into the blackness, conditions improved somewhat, and the line was advanced through the apartment. The officer then ordered the nozzle shut down. As the smoke began to lift, he realized he was kneeling in the middle of the fire room! He stated that throughout the fire attack, he never saw so much as a lick of flame despite a well-advanced fire.

A friend of mine, a very experienced firefighter, described to me the next incident: At a recent training exercise in an acquired structure, student firefighters were preparing to advance a charged handline through the kitchen and extinguish a fire at the far end of the adjoining living room. He was assigned as the engine company officer to coach the students through the exercise and ensure their safety. The fuel materials consisted of an upholstered sofa on end, one or two seat cushions, and cardboard as kindling. After the fire was lit, he entered the house to check on fire conditions and verify that the ignition officer was safely removed to the outside. From the doorway between the kitchen and living room, he noted that flames were starting to roll across the living ceiling, but visibility was still good, and nothing seemed out of the ordinary. He then duck walked the 15 feet back to the entrance door and instructed the student firefighters to bring the line inside. In less than a minute, conditions in the kitchen and living room had changed drastically. Almost all visibility was lost, and dark smoke was banked down to within two feet of the floor in the kitchen and to within an inch or two in the living room. As they advanced the line into the living room, he was unable to see even a hint of fire at ceiling level. With a high heat condition and the very real threat of flashover, he told the nozzleman to open the line. This action more than likely saved them from severe burn injuries.

I had an experience at a private dwelling fire several years ago that is eerily similar to the incidents described above. The occupants of an older, 2 1/2 -story, two-family home reported a smoke condition in the attic. We brought a charged handline up the stairs to the attic and were met with heavy, dark smoke. With no visible fire and a moderate heat condition, I thought the fire might be behind a knee wall or above a finished ceiling, but there were no void spaces present. Heat levels continued to increase. Crouching down, I could feel a significant amount of heat on my thighs and groin area (I was wearing a protective hood but only 3/4-length boots). After inching ahead slowly, I caught a glimpse of what looked like glowing coals at floor level. I opened the nozzle, sweeping the ceiling and floor. We then advanced the line toward the front of the house (the attic stairs were closer to the rear), and I was able to vent the attic through a small window that had remained intact during the fire. The fire itself involved a foam mattress and some clothing, which explains the dense smoke and intense heat. Because of the confinement of the fire in the attic with its limited ventilation opportunities, we most likely encountered a fire in the third (smoldering) stage of development. Because we entered the attic from below, the pressure of the heated gasses initially prevented intrusion of any significant additional oxygen. But had I not opened the line when I did, I believe it would have been just a matter of time before the attic would have "lit up" in flames.

COMPARTMENT FIRES

One recent *Fire Engineering* article cited a scientific principle known as "Thornton's Rule" as the basis for concluding that fires today are no more challenging and dangerous than in the past. I disagree with this conclusion and believe that the widespread use of plastics has significantly increased the hazards posed by interior fires. Let's examine Thornton's Rule, not from a theoretical, laboratory perspective but from one grounded in the reality of the fire floor. We'll begin by comparing the heat energy potential of various plastics vs. more traditional fuel materials. The heat of combustion (heat energy potential) of plastics is tremendous and ranges from approximately 16 kJ/g for polyvinyl chloride (PVC) to approximately 41-46 kJ/g for polystyrene and high-density polyethylene. Both polystyrene (rigid and expanded) and polyethylene are widely used in consumer goods and building materials. By contrast, paper, wood, cotton, jute, and other natural (cellulosic) materials have much lower heat energy potentials, in the range of 12-15 kJ/g. What Thornton discovered before World War I was that in any oxygen-regulated fire (compartment fires are generally oxygen- or ventilation regulated, whereas outside are fuel-regulated), heat of combustion will not vary significantly for a variety of organic liquids and gases. In the 1970s, further research by Hugget indicated that the heat of combustion for many organic solids is also relatively constant and is a factor of the oxygen available for consumption within the fire compartment. Although these laboratory findings viewed independently may indicate that plastics pose no more of a hazard to firefighters than the cellulosic materials of fires past, at "real world" fires, other factors (variables) add elements of dynamic complexity to the behavior of interior fires and suggest that the dangers faced by firefighters have increased dramatically in the past 50 years. These factors may be related to the fuel materials themselves (amount, flame spread rating, surface-to-mass ratio, arrangement, and heat release rate), the compartment (insulation, ventilation), and firefighting actions.

FUEL MATERIALS

Fire load (sometimes called fuel load) refers to the total heat energy potential of the combustible materials contained in a building (or compartment). Expressed in SI units as kJm2, under most definitions, the term *fire load* includes both the contents and any combustible structural components. As society has grown more affluent, families have introduced increasing amounts of combustible material into their homes and apartments. By some estimates, the average residential fire load is at least two times greater today than it was 50 years ago. Even if heat production doesn't vary significantly between plastics and cellulosics burning within a compartment, if the amount of combustible material increases, so, too, must the heat energy potential. This might be called the “more stuff, more heat” principle.

Another important factor is flame spread. High rates of flame spread across exposed fuel surfaces decrease the safe operating time for firefighters before flashover occurs. The use of plastic materials as wall and ceiling coverings, as well as in furniture and furniture veneers, greatly increases the risk of rapid fire development and firefighter injury. “Very high surface flame spread rates have been reported – up to approximately 2 ft. per sec. (0.6m/s), or 10 times the rate of flame spread across most wood surfaces.” But let’s not forget that wood and other cellulosic wax and ceiling finishes also produce dangerously high rates of flame spread. Exposed wood surfaces, such as paneled walls, can contribute to rapid fire development, particularly when flammable glues or adhesives are used in the installation and the paneling itself is subject to delamination when exposed to excessive heat. In *Building Construction for the Fire Service, Third Edition,* Frank Brannigan details the extreme flame spread hazard posed by combustible acoustical ceiling tiles made of low-density fiberboard. Paints, coatings, and other surface finishes also play a role in flame spread, but to what extent is not well defined.

The surface-to-mass ratio of the fuel is another factor. Obviously, expanded plastics pose a significant hazard in this regard, but consider a rigid plastic form that is in common use as a storage place for everything from toys to videotapes to vintage record albums-the milk crate. Now commercially manufactured specifically for home and office storage applications, milk crates have a very high surface to mass ratio. Recently retired Fire Department of New York (FDNY) Deputy Chief Vincent Dunn believes that a variety of rigid and expanded plastic items, including several milk crates filled with toys, contributed to a flashover that fatally injured FDNY Captain James F. McDonnell in 1985. Another possible contributing factor in McDonnell’s death was the arrangement of the combustible material (also known as fuel “geometry”). Consider the impact on fire growth and spread of perhaps two dozen plastic milk crates stacked five and six high or even nailed to the walls of a typically sized bedroom or living room during a fire. Filled with plastic toys or other items, they might be likened, in the words of one fire officer, to “bombs” of solid gasoline. According to Vytenis Babrauskas, Ph.D., a leading researcher in the field of compartment fire growth dynamics, the most important factor in the speed with which a fire reaches flashover is the heat release rate (HRR). Put very simply: “If the HRR is high enough, flashover will occur. If it’s not, the fire won’t reach flashover...” Fuel materials that have high rates of heat release, including many plastics, generate significant heat early in the development of an interior fire before fire growth becomes strictly ventilation-regulated and heat production levels off, “The heat release rate is important during the growth phase of the fire when air for combustion is abundant and the characteristics of the fuel control the burning rate”. Cellular plastic items, such as foam-filled mattresses and furniture, are extremely hazardous in this regard. This is because of the characteristics of cellular plastics: They have a low density; they have very high heat release potentials; and they tend to liquefy and gasify (not char) when they burn. The *Fire Protection Handbook*, in discussing the heat release rate of upholstered furniture (encountered at virtually every residential fire and a major culprit in the “black fire” examples described earlier), states the following: “The HRR of upholstered furniture can, in the worst circumstances reach values of around 2,000 to 3,000 kW (2 to 3 MW) in a very short time, only 3 to 5 minutes after ignition.” The *Handbook* continues by noting that the hazard is extreme “since it only takes about 1 MW to flash over a room with a normal-sized door opening.” While one can never predict with absolute certainty the outcome of any compartment (room) fire based strictly on the composition of the fuels involved, the higher energy potentials and high heat release rates of modern plastic furnishings and finishes make early flashover and severe firefighter injury more distinct possibilities. In tragic testimony to the dangers posed by interior fires today, between 1985 and 1994 alone, approximately 47 firefighters suffered fatal injuries as a result of being caught or trapped by flashover and other “rapid fire progress” events.

ENERGY-EFFICIENT WINDOWS

Consider the following quote from an article written by Deputy Chief James Murtagh of FDNY more than 10 years ago: “Fires in buildings with energy-efficient, double-paned windows will contain smoke and fire for extended periods. This leads to delayed alarms and the development of large volumes of extremely dense, pressurized smoke which will bank down farther than normally expected. If the smoke is hotter than its ignition temperature, but too rich to burn, it may ignite suddenly when sufficient oxygen is mixed with it; if the gas-air mixture is within its explosive range bur below its ignition temperature, it may ignite suddenly when heat is added.

The widespread installation of double-glazed, energy-efficient windows has added so many complicating factors to firefighting efforts in New York City that procedural bulletins have been changed specifically as a result. Fifteen years of field experience with these windows at literally thousands of fires indicates that (a) they do not fail as readily as older, single-glazed windows; (b) in multiple dwelling and commercial installations, the resistance to failure is increased because of the use of heavier-gauge aluminum or vinyl frames); (c) because they resist heat-induced failure, they often hide the location of the fire from firefighters assigned to perform ventilation and search operations from ladders and fire escapes; (d) EEWs are extremely difficult to break with firefighting hand tools; and (e) once the windows do fail or are vented, fire conditions often change dramatically. For a more complete discussion of the hazards and problems posed by EEWs see “Energy-Efficient Windows” on page 134.

FIREFIGHTING ACTIONS

Because of the behavior of EEWs, many times the first (and only) ventilation of the fire area is the door opening through which first-arriving firefighters begin their primary search and advance the attack handline. Once this door is opened, anticipate a dramatic change in fire conditions. Consider the following example. An engine company prepares to advance a charged 1 3/4-inch hand-line through the front door of an apartment. A long hallway connects the entrance door with the fire room deep the “flat.” Volumes of dark smoke under considerable pressure are “pushing” out the open apartment door and rising up the stairway. As the nozzle team disappears into the murk, flame begins issuing intermittently from the top of the door opening. The nozzle team, unaware of these conditions, continues to advance down the hallway toward the seat of the fire. Suddenly, heavy fire is “blowing” out the top half of the door opening, and the hallway has turned into a mass of orange flames. The nozzleman finally opens up, but not before he and the backup firefighter have sustained second- and third-degree burns. What happened? The fire burning within the unventilated (or poorly ventilated) apartment described above is akin to a flammable gas factory. Large amounts of heated, un-ignited combustion gases (carbon monoxide mostly) outflow from the main fire area (maybe a rear bedroom) and accumulate in the adjoining rooms and spaces. When the door to the apartment is opened (a ventilation opening), these fire gases travel along the ceiling toward this outlet. As the gases reach the entrance door, they begin missing with ever-increasing amounts of oxygen, causing the vapor-rich mixture to enter its flammable range. With the door kept open to permit advance of the handline, the intermittent flaming at the top of the door opening is soon replaced with solid fire. As increasing amounts of oxygen flow into the apartment through the open door, the flames travel back toward the main fire area, feeding on the ceiling gases, giving the appearance of a lit fuse. Sometimes termed “vent point ignition,” the entire hallway is soon filled with fire, and the nozzle team is literally fighting for its life.

One question that may be asked is why the nozzleman didn’t open up sooner. While rollover (flames appearing in the overhead smoke layers) is a reliable warning sign of impending flashover, it cannot provide warning if it goes unnoticed. Flames in the overhead may not be visible because of smoke once entry is made into the fire occupancy. The full encapsulation and exceptional thermal protection provided by the latest bunker gear and protective hoods may prevent firefighters crouching below from feeling heat radiating downward from above. In this case, the nozzle man never opened up because he didn’t realize the severity of the situation.

Another question concerns the position of the entrance door. Should the entrance door have been partially closed behind the advancing firefighters to limit air movement and delay or prevent flashover? In my opinion, once a handline passes through a door opening, the door must remain fully open to prevent any interference with the movement of the line and to allow an influx of fresh air to aid in ventilation as the fire is knocked down. During the primary search, however, the question is more difficult to answer and is the subject of much debate within the ranks of FDNY. A veteran lieutenant assigned to a busy ladder company in the Bronx believes that at apartment fires, the door should be kept closed during the primary search (not locked or latched, just shut to limit air movement). The calming effect on a growing fire that results from the simple act of closing the door behind you can be quite astonishing.

At a fire in a multiple-dwelling in the Bronx, the first-due ladder company initiated a primary search with the apartment door closed. To complete the search, the firefighters had to pass the fire room. A 2 1/2 -gallon water extinguisher (commonly called the “can,” carried by all FDNY ladder companies during primary search operations) was discharged on the fire, but the “can” firefighter was unable to pull the fire room door shut. When the engine company officer opened the apartment door to check on conditions, the fire roared out of the fire room and filled the hallway, trapping the search team at the rear of the apartment. As soon as the apartment door was closed, the fire retreated back into the room. This condition was observed again after the primary search had been completed and the handline was brought inside to extinguish the fire. The effect of open doors and windows is enhanced greatly during windy conditions. Depending on wind direction and velocity, extremely rapid fire progress may result. The fire service has an insufficient understanding of how wind and other weather-related factors affect fire behavior; much research remains to be done.

Another question concerns the issue of applying water on smoke. For years, it was considered taboo, but the volatile nature of the smoke produced by the contemporary fire environment requires that we rethink this approach. “Although this [applying water on smoke] flies in the face of traditional training, we must recognize that the fire environment has changed with the addition of plastics that generate high heat and dense smoke when they burn. This, combined with energy-efficient windows, may justify putting water ‘on smoke’ to prevent flashover in certain situations”. While this tactic should remain the exception and not the rule, if you find yourself lying in a hot, smoke filled hallway and that dread feeling in the pit of your stomach tells you that something very bad is about to happen, opening the nozzle may very well save your life.

FOG, FANS AND FOAM

Part 1 of this article described our 50-year experiment with fog streams and the mixed success they’ve achieved on the fireground. Although fog streams did not turn out to be the “magic pill” some had hoped, the jury is still out on other, more recent “advancements” in the art and science of interior fire control. Specifically, I’m referring to positive-pressure ventilation (PPV), Class A foam, and “offensive” water fog techniques.

-PPV

Does PPV have a place? I believe it does, particularly during overhaul, to reduce heat and humidity levels and clear the fire area of smoke. It has also shown much promise when used to pressurize stairways during high-rise fire evacuation. During the initial stages of a fire attack, however, it poses several problems.

First among these is the danger of pushing fire into uninvolved areas of the building. Another is the potential for violent acceleration of fire growth. At one training burn in an acquired structure, the local fire department wanted to experiment with PPV. The action of the fan on the fire suggested that someone had injected atomized gasoline into the fire area. Setting up a PPV fan also requires that a firefighter or firefighters be taken away from other important tasks and, considering the staffing levels of most engine and ladder companies, this becomes an important issue. If vent-enter-search (VES) operations are employed. PPV will drive heat and flame toward the searching firefighters and cause severe burns and other injuries as they scramble to dive out windows and escape serious burns.

One investigator suggested installing small nozzles on the perimeter of the fan to blow a water mist into the fire area (similar to the cooling fans seen on the sidelines during football games in warm weather). This introduces the very real danger of steam burns and is similar in effect to having a misplaced fog stream directed through a window opening while you are inside the fire building. As a result of these issues, many fire departments that practice PPV do so on a much more limited basis today than previously.

-*Class A foam*
The current buss in “progressive” fire suppression circles is Class A foam. Class A foams are not new – they’ve been around for almost a century. Used in wildland firefighting for many years, they have only recently been introduced into the arena of structure firefighting, A am not disputing some of the advantages offered by wetting agents in general and Class A foams in particular (better fuel penetration and the ability to cling to vertical surfaces), but they are not quite the panacea some salespeople would have us believe. In a fairly extensive study conducted by the National Institute of Standards and Technology (NIST) on the performance of Class A foam, testing showed that its most clear advantage over plain water was in the extinguishment of tire fires. In other tests, the advantages offered by Class A foam were less well defined. The NIST report also indicates that there are little quantitative data on the effectiveness of Class A foam vs. plain water in the extinguishment of interior structure fires and that more testing is required.

In addition to incomplete information on the effectiveness of Class A foam, there are other issues to consider. I hate to be a pessimist, but my experience with Class B foam systems installed on municipal fire apparatus hasn’t been good. They often don’t work properly when you need them, especially when they’ve been dormant for months at a time. And having been a firefighter in two paid municipal departments, a combination department, and a small volunteer department, I also understand the issue of budgets. Many fire departments lack funds to maintain basic necessities like turnout gear and SCBA, let alone to invest in Class A foam systems. Other questions must be answered as well. If a foam system is purchased, will it be adequately maintained? Will firefighters be permitted to use foam during routine training sessions to ensure proficiency in proportioning and application techniques, or will this prove too costly? Have your firefighters been properly trained to extinguish fires using water plain first so that when the foam system fails, fire suppression efforts can continue uncompromised? While there is no doubt that the use of Class A foam will continue to expand, there exists to date insufficient scientific data and actual field experience to provide a true cost-benefit picture of the effectiveness of these agents in interior structure fire attack.

LITTLE DROPS AGAIN
As a result of two Swedish firefighters being killed in a flashover in the early 1980s, fog nozzle techniques were devised to counter the effects of fire gas ignition and prevent injuries from flashover and backdraft. Termed “offensive” or “three-dimensional” water fog application, these techniques have been explained in great detail in the writings of Paul Grimwood, a retired 26-year veteran firefighter from the London Fire Brigade. Grimwood was kind enough to address my questions and concerns about “3-D” fog techniques. Although I agree with his assessment of the modern fire environment and its attendant hazards-particularly the volatile nature of fire gases and the increasing

hazards of flashover and backdraft-I disagree with several of the specific tactics he advocates.

The brief examination of 3-D water for techniques contained here is taken from a pamphlet entitled “Flashover & Nozzle Techniques” prepared by Grimwood. Offensive fog application requires that small (around 400 micron) droplets produced by special fog nozzles be directed into the overhead gas layers in short bursts or “pulses.” The objective is to suspend the droplets in the gases to cool them and retard their ignition (in other words, putting water on smoke as a preventive measure). While ideally 3-D fog application will prevent ignition of the fire gases, Grimwood states that the technique is suitable for both pre- and post-flashover fires. As the water fog turns to steam and expands in volume, it is accompanied by a corresponding decrease or contraction in volume of the fire gases, reportedly avoiding the debilitating effects associated with steam production caused by fog streams during interior firefighting efforts. In addition, by avoiding contact between the water and the heated walls and ceiling (opposite of what the combination method of attack requires), unwanted steam production is further reduced, thereby maintaining tenable conditions for the nozzle team.

Offensive fog techniques require rather precise execution for success. Grimwood states that firefighters employing 3-D fog techniques should be “extremely well practiced in nozzle handling and ‘pulsing’ actions”. Given the wide spectrum of distractions faced by the modern fire service (EMS, haz-mat, technical rescue, and so on) and the youthful look of many fire departments, handline and nozzle techniques must be kept as simple and straightforward as possible. Regardless of its reported effectiveness, offensive fog application does not fit this description. I believe a more traditional approach is in order.

INTERIOR DIRECT ATTACK

Fifty years after Layman’s “Little Drops of Water”, it’s time to admit that fog streams are not the answer. I strongly advocate a return to the time-tested direct method of attack. Its simplicity and effectiveness, coupled with the level of safety it affords the nozzle team, is a good fit with the unpredictable fire grounds of the new millennium. While solid streams are preferable, straight streams may be substituted, provided that fire flows are not compromised. The following tactics and techniques will ensure success when employing an interior direct attack: Due to the volatility of today’s fires, a minimum fire flow of 150 gpm is recommended for residential fires. This flow is easily achieved using 1 3/4-inch hose, provided friction losses are accurately determined and correct pump discharge pressures are used.

One firefighter told me that when his department flow tested its 1 3/4-inch preconnected handlines using its standard pump discharge pressures, the average flow was only 84 gallons per minute (gpm). While in theory 84 gpm, properly applied, will extinguish a significant amount of fire, a flow this low allows no room for error and does not provide any reserve to handle unforeseen contingencies. Commercial building fires demand a minimum fire flow of 250 gpm, and this is best delivered through 2 1/2-inch hose using solid bore nozzles. Other parameters that deserve consideration include the minimum effective reach of stream (50 feet for streams used in residential firefighting) and the nozzle reaction burden. Nozzle reaction forces should be no greater than 60 to 70 pounds. Field tests have indicated that a reaction force exceeding 70 pounds is very difficult for a single firefighter to handle. Realizing that a backup firefighter is most often a luxury and that even when present he will often be positioned well behind the nozzleman to pull hose around corners and feed it forward to the nozzleman as he advances, the reaction burden that can be safely handled by a single firefighter becomes a very important safety issue. Since nozzle reaction is a factor of the weight (volume) of water being discharged and the nozzle pressure, nozzle reaction can be made more manageable by reducing flow volume (an unwise decision) or decreasing nozzle pressure. The only effective means of reducing nozzle pressure without adversely impacting firefighting effectiveness is to employ solid stream tips or low-pressure fog nozzles.

Unlike each of the fog firefighting methods that involves the application of water into the heated overhead to cool the gases, direct attack goes to the root cause of the problem-the source of gas production. David Fornell, in *Fire Stream Management Handbook*, uses the analogy of a propane cylinder leaking a jet of burning gas. The heated solid furnishings and finishings within a burning room are likened to the leaking cylinder; flammable carbon monoxide is substituted for the propane gas. In controlling a leaking and burning LPG cylinder, the goal is to control the fuel supply-the cause of the problem, as opposed to first extinguishing the burning gas-merely a symptom. The goal of the interior direct attack is to apply water *directly* on the heated solid materials within the fire area, reducing their temperature and halting the production of flammable carbon monoxide gas. “In any space containing heated gases which are likely to flash over or in any area already flashed over, cooling the heated solid material providing the fire’s fuel must take place to successfully stop the fire. Getting water onto the heated materials, however, is often easier said than done.

In addition to using the reach afforded by solid and straight streams, the ceiling and upper walls may be used to redirect the stream when heat conditions or obstructions (partitions, piles of stock, partially closed doors) make application immediately to the base of the fire impossible. Sweeping the ceiling with the stream in a side-to-side or clockwise motion also helps eliminate the threat posed by the heated gases without excessive unwanted steam production and violent disruption of the thermal balance characteristic of the indirect and combination methods. Unlike 3-D fog application, which involves cooling the gases with very small water droplets, sweeping the ceiling with a straight or solid stream causes an action that the late Floyd Nelson termed “rattling the fire’s chain.” “Inside the area of the flame, the chemical reactions that take place are often referred to as chain reactions. These chain reactions depend on a smooth flow of oxygen and a smooth flow of fuel vapors to continue their act of combustion”. Nelson calls it the “straight stream off ceiling” attack, and he states that it is highly effective in disrupting the flow of oxygen and fuel, thereby reducing the threats of rollover and flashover.

In addition to agitating the gas layers, using the ceiling to break up the stream creates coarse droplets that will rain down on the burning solid materials and start the cooling process. Unlike the fine droplets that compose spray streams, the droplets created by splattering stream on the ceiling will be larger and heavier and less likely to vaporize prematurely or be swept away by convection currents. There is another reason for initially directing the stream at an upward angle anytime a fire has progressed to the point where flames are traveling across the ceiling. If a solid or straight stream were to be directed immediately into the lower portion of a well-involved room, the expansion of the water to steam could cause a violent displacement of burning fire gases, which might result in burn injuries to the nozzle team. The stream itself might cause burning debris to scatter, and unwanted steam creation would be increased. (This should not be confused with the action of sweeping the floor with the stream periodically during the advance to push aside glass and debris and cool heated objects and scalding water runoff.)

Lastly, the importance of patience on the part of the nozzle team must be stressed, before entering the fire occupancy with a charged handline, pause momentarily, and observe the smoke venting through the door opening. Try to get a read on the its pressure and temperature, and pay attention to its color. Veteran firefighters know the importance of “lying low and letting it blow.” By waiting briefly at the door, the severity of fire conditions can be gauged, and burn injuries caused by the sudden ignition of fire gases can be prevented. Sometimes, by looking back and studying the proven tactics and techniques employed by firefighters of generations past, we can best learn methods for staying alive at the fires we confront today.

Fire Engineering
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IMPROVING THE QUALITY OF YOUR SOLID STREAMS

BY JIM REGAN AND ANDREW A. FREDERICKS

Surprisingly, very little research has been conducted into the development of effective solid fire streams. With fire departments returning to the use of solid stream nozzles in large numbers, we thought it was important to explore various factors that affect the quality of the solid streams produced by handline nozzles and master stream appliances. Although solid stream nozzles are simple to operate and maintain, the importance of producing streams of superior quality should not be taken for granted and will result in safer, more effective performance on the fireground.

FREEMAN EXPERIMENTS

According to the Fire Protection Handbook, Thirteenth Edition: "Much of the fundamental data now employed in hydraulic work in fire protection was developed in a series of extensive investigations conducted by John R. Freeman in 1888 and 1889." Freeman compared streams from more than 40 different nozzles, and the data collected from these tests resulted in the design of the "Underwriter's Playpipe," still widely used in flow testing of all kinds. Freeman also defined what he felt constituted a "good" fire stream, and these factors have remained undisputed for more than 110 years. He defined a "good" fire stream as one that:

-had not lost continuity by breaking into showers of spray

-appeared to shoot 90 percent of the volume of water inside a 15-inch-diameter circle and 75 percent of the water inside a 10-inch-diameter circle as nearly as could be judged by the eye

-would probably be stiff enough to attain height or distance in fair condition, even if a fresh breeze were blowing

-with no wind blowing, would enter a room through a window opening and strike the ceiling with force enough to spatter well

It is evident that evaluating a solid fire stream for quality is highly subjective and truly "in the eye of the beholder." Nevertheless, we must not diminish the importance of having "good" fire streams and the benefits they have in both fire control and exposure protection.

FACTORS

What factors must you consider to obtain a "good" fire stream from a solid stream nozzle? Some are obvious and apply to nozzles of all types, but each is vitally important in attaining a stream of the highest quality, which in turn translates into improved performance and a higher degree of operational safety. The first factor is the nozzle pressure. Most handline solid stream nozzles are designed to operate at 50 psi, master stream nozzles at 80 psi. Too high a pressure will cause the stream to break up prematurely; too low a pressure, and the stream will falter. The second factor concerns the nozzle tip size. The tip selected should be properly sized for the required flow. Although some leeway exists with tip size, trying to squeeze more volume through an undersized tip will result in premature stream disintegration. Too large a tip, and the sheer weight of the water being discharged will produce a nozzle reaction force that may be difficult to control. A third factor is the condition of the nozzle. Burrs or other imperfections in the waterway (tip and shutoff assembly) will harm the stream. A nozzle tip "out-of-round" will significantly compromise stream quality. A fourth factor concerns the hose layout (length, size, deployment). Hose supplying the handline and master solid stream nozzles should be of sufficient size to provide the required flow and deployed so as to minimize turbulence. Turbulence caused by kinks in a handline, particularly when they are close to the nozzle, will wreak havoc with solid stream quality. The fifth and final factor is the design of the nozzle or the appliance to which it is attached. This includes the length of the nozzle tip(s) and the use of a stream straightener (also called a stream shaper or discharge pipe) to reduce turbulence.

The next section will examine and compare various master stream nozzle configurations in an effort to produce the highest quality solid stream.

TESTING

In August 1999, with the assistance of Captain Kenneth Wojtecki and the members of Chicago Fire Department Engine Company 47, a series of subjective tests were conducted utilizing various tips and stream straighteners attached to a portable multiversal nozzle.

Three types of master stream nozzle configurations were evaluated:

1. 1 1/2-inch tip (triple stacked tips) with long (10.5-inch) stream straightener;
2. 1 1/2-inch interchangeable tip (nine inches long) with both long stream straightener and short "honeycomb" stream straightener; and
3. 1 1/2-inch Stang Aeroglas Shaper Tip® with both long streamstraightener and short "honeycomb" stream straightener.

The portable multiversal nozzle was fed by a four-inch supply line looped around the front of the appliance for stability. The nozzle pressure was measured at 80 psi for each series of tests. Stream quality was evaluated by those present for conformance to Freeman's definition of a "good" fire stream.

RESULTS

Since smoother or more laminar flow into and through a nozzle and tip assembly produces a better fire stream, reducing turbulence is essential to achieving "good" stream quality. As can be seen in photos 5-7, the stream quality produced by the first and third tip configurations were essentially identical (photo 5-triple stacked tips with long stream straightener; photo 7-Stang Aeroglas Shaper Tip with both stream straighteners). The second tip configuration, even with the addition of the "honeycomb" stream straightener, produced a demonstrably inferior stream. Based on these limited evaluations, it appears that the length of the tip is at least as important as the length and type of stream straightener in producing high-quality solid master streams.

HANDLINE NOZZLES

One of the major concerns expressed by firefighters using solid stream nozzles is that, as a result of the lower nozzle pressure, the handline has an increased tendency to kink. Kinks can severely restrict the flow and will have a decidedly negative impact on stream quality, particularly when the kink occurs close to the nozzle. It has been said that the first five to 10 feet of hose behind the nozzle should be considered part of the nozzle and must be kept as straight as possible to ensure a stream of "good" quality. Under fireground conditions, this is often very difficult to achieve. Even relatively small bends in the hose can have an adverse effect on the stream.

We wanted to evaluate the effect that a small "honeycomb" stream straightener would have on handline stream quality. We utilized the Chicago Fire Department's standard "shutoff pipe" (2 1/2-inch solid stream nozzle fitted with a 1 1/4-inch tip) for the tests. As can be seen in photos 9 and 10, the addition of the stream straightener between the controlling handle (shutoff) and the tip results in a smoother, higher quality stream. The use of a stream straightener causes the turbulent flow entering the nozzle tip to "recover" some of its laminar characteristics, even when a bend in the handline is formed in close proximity to the nozzle. Stream straighteners are now available specifically for handline applications and are rapidly attracting a loyal following. Keep in mind two cautions when using a handline stream straightener. First, one of the advantages of solid stream nozzles is that they do not clog readily. Although a stream straightener can have a very beneficial effect on stream quality, it introduces both a clog point and an increased potential for ice formation in the waterway. Second, care must be exercised in the placement of the stream straightener. If it is placed between the hose and nozzle, the line would have to be shut down or clamped and the nozzle unthreaded from the hose should it become clogged with debris. It must be placed between the controlling handle (shutoff) and the tip. If it becomes clogged in this position, the nozzle can be closed and the tip and stream straightener easily removed to clear the obstruction.

Another potential means of improving the quality of handline solid streams is to lengthen the nozzle tip. We compared the streams produced by the standard handline nozzle used by the Fire Department of New York (FDNY) and an identical shutoff equipped with a longer tip. The nozzles were attached to portable master stream devices to maintain identical 35 degree discharge angles and to keep turbulence to an absolute minimum. The FDNY nozzle used with 1 3/4-inch hose consists of a 15/16-inch tip and a 1 1/2-inch shutoff (1 3/8-inch clear waterway). The tip is 3.75 inches in length. The manufacturer of the standard FDNY nozzle supplied us with three six-inch-long prototype tips (15/16”,1”, and 1 1/8-inch) for testing. In a series of side-by-side comparisons to evaluate effective stream reach and overall stream quality, the six-inch-long, one-inch-diameter tip produced the smoothest stream with the longest reach. In addition, flow volume increased by approximately 40 gallons per minute over the standard 15/16-inch tip.

These test results subjectively confirm what many busy FDNY engine company officers and firefighters have believed for years: Longer, larger tips "kill" fire much more effectively than smaller, more compact solid stream tips. Obviously, a larger tip means more flow volume at the same pressure, but it is felt that a longer tip maintains better stream performance (effective reach, compactness) as the handline is turned and bent while advancing through the narrow hallways and crowded rooms of New York's brownstones, tenements, and apartment houses.

Another interesting fact concerning nozzle tip length affects those fire departments that have adopted "break-apart" nozzle systems incorporating solid stream "slug" tips. We assumed that the stream from such a short tip would be rather sloppy; but, in fact, with proper nozzle pressure it is quite good. The reason, we have learned, is that the shutoff itself acts like an extension of the nozzle tip, creating, in essence, a longer tip and a "cleaner" solid stream.

Finally, when discussing the quality of solid streams produced by handline nozzles, one additional point bears mentioning: It is vital that the ball valve be fully open during fire attack operations. Otherwise, the projection into the waterway caused by the partially closed valve will disrupt the stream and greatly diminish its characteristics.

NOZZLE REACTION

It is irrelevant to discuss the quality of the solid stream produced by a handline nozzle if the nozzle reaction burden makes the line unmanageable. A major benefit of solid stream nozzles is that at equal flows, a solid stream nozzle will produce approximately one third less reaction force than a 100-psi fog nozzle set to straight stream position. But many times, solid stream nozzles are still difficult to control, and to discover the reason for this requires that we explore the concept of nozzle reaction a little more completely. Elementary Newtonian physics teaches us that when a force is applied to an object, the object (in this case the water being discharged from the nozzle) exerts an equal but opposite force (in this case known as nozzle reaction). Nozzle reaction, sometimes termed "backpressure," is a force (measured in pounds) exerted in the opposite direction of stream discharge. If this force is too great, the nozzleman will have to fight the tendency of the nozzle to slide backward through his hands, rapidly fatiguing his arm muscles and reducing fire extinguishing effectiveness in the process. Nozzle reaction is a factor of both the nozzle pressure and the weight of the water being discharged. Since higher flows mean more water weight, nozzle reaction increases as tip size increases. Studies have shown that a nozzle reaction force exceeding approximately 70 pounds is too difficult for a single firefighter to handle safely. While ideally a firefighter will never be left alone at the nozzle, in reality, the backup firefighter (if present) is often several feet behind the nozzleman pulling hose around corners and struggling to keep the line moving. How, then, do we reduce nozzle reaction without sacrificing the flow volume that is critical for expeditious fire control and firefighter safety? The solution is two-fold: First, we must decide on a minimum safe fire flow for both residential and commercial fires. Second, we match the appropriate tip size capable of producing this minimum flow to the size of the nozzle crew and their average level of training and experience.

For some reason, many firefighters believe that the FDNY standard 15/16-inch nozzle tip is the only tip size that can be effectively used with 1 3/4-inch handlines. This is simply not true. At 50-psi nozzle pressure, a 15/16-inch tip will flow 182 gpm and produce a nozzle reaction of approximately 66 pounds. While this is within the safe range for handling by a single firefighter, in reality, it can be very difficult to control and advance a line flowing 182 gpm unless the nozzleman is well experienced. In addition, if the nozzle pressure exceeds 50 psi (a common problem among pump operators accustomed to supplying 100-psi fog nozzles), the reaction burden may quickly become excessive. Although the 15/16-inch tip works well in New York City, many fire departments lack the staffing to use such a large tip successfully. For these departments, the 7/8-inch nozzle tip may very well be the answer. Given the nature of the contemporary fire environment, it is our contention that residential fire flows less than 150 gpm are unsafe and do not provide efficient use of 13/4-inch hose. At 50 psi, a 7/8-inch tip will flow approximately 160 gpm with a nozzle reaction burden of only 57 pounds. In the sidebar "The Retooling of the One-Inch Smooth Bore Tip" on page 62, the St. Petersburg (FL) Fire Department found the 7/8-inch tip ideal. The authors point out that with a 15/16-inch tip, any over-pressurization causes excessive nozzle reaction. If the nozzle is underpressurized, there is an increased tendency for kinks to form. Unless the line can be maintained straight behind the nozzle (unlikely, unless a backup firefighter is always behind the nozzleman), kinks that form near the nozzle can be very dangerous. When the line kinks, the flow is drastically reduced. As soon as the kink is straightened, the sudden release of energy results in a pressure surge at the tip that can cause the nozzleman to lose control of the line. The experience of the St. Petersburg Fire Department indicates that problems with kinks and line control are far less severe when a 7/8-inch nozzle tip is used. Of course, if a sufficient number of experienced personnel are available, tips larger than 7/8-inch can be used with great success. A favorite among busy FDNY engine companies is the one-inch solid bore tip. It produces a reaction force of about 75 pounds at 50-psi tip pressure while flowing more than 200 gpm. FDNY engine companies can use this line effectively because their staffing always provides for a nozzleman and backup man (under an officer's supervision) to work together as a team. This eases the reaction burden and permits effective handling of the nozzle. Regardless of the tip size or nozzle type, safe and effective use of any handline nozzle requires constant practice and a mastery of proper nozzle mechanics.

As far as a minimum required flow for commercial building fires is concerned, 2 1/2-inch hose and flows of at least 250 gpm are strongly recommended. Suffice it to say that the safe and effective use of 2 1/2-inch handlines involves several additional considerations that will not be addressed here. For more information on the need for and proper use of 2 1/2-inch handlines, see the articles "1 3/4-Inch Hose: The Booster Line of the '90s?" by James J. Regan (Fire Engineering, September 1993) and "The 2 1/2-Inch Handline" by Andrew A. Fredericks (Fire Engineering, September 1996). You must adhere to the basics of proper fire stream development regardless of the type of nozzle you use. An adequate water supply, proper nozzle pressure, proper tip size, the correct hose layout, and equipment in satisfactory condition are essential to the development of a "good" fire stream. Our limited subjective analysis reveals that the type of stream straightener, the length of the nozzle tip, and the elimination of kinks in the handline will produce streams that are much more likely to meet the criteria established by Freeman more than 100 years ago and will keep firefighters safe as they rise to meet the challenges posed by today's fireground.

Fire Engineering
June 2000

Responses to Little Drops of Water as posted in Letters to the Editor

I recommend that your readers hold on to the February and March 2000 issues containing "Little Drops of Water: 50 Years Later," Parts 1 and 2, by Andrew A. Fredericks. These articles will make the history books. They are the most significant papers to be published in any publication for a very long time. In addressing the controversy over "fog streams" and "solid streams," Fredericks has eliminated the debate. He should be commended for his extensive research and his commitment and dedication to improving this great profession.

Ted Corporandy
Battalion Chief
San Francisco (CA) Fire Department

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I have read with much interest Andrew A. Fredericks' articles concerning fire extinguishment in the early '80s. After spending much of my childhood around the fire service, I had my chance to get my hands on a nozzle and experiment. I have seen the over-application of water in the indirect mode "baking" the hose team. I learned the lesson the hard way. Over the years, I have found that a narrow fog worked in an aggressive manner into the ceiling area to break up the drops works best. Follow it up by applying water directly onto the material in question. The use of the narrow trimmed stream allows you to interrupt the combustion process from a fairly safe distance and cool the fire area prior to entry. I like having a combination nozzle; I use the wide fog for ventilation purposes.

Currently in my company, we now know where to set our nozzle to give us the desired stream for fire attack and when to switch to a wider stream for venting the gases. This process seems to work well, and we preset the tip at the start of each tour before the "bells" come in.

I feel also that it is important to develop in new firefighters the ability to read the fire and to use nozzle and stream selections to best advantage. This combined with live training will surely give the hose team the know-how to apply the wet to the red safely and in the proper form. Congratulations to Fredericks on a well-written and researched piece.
Todd A. Reese
Wilmington, Delaware

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I very much enjoyed reading Andrew A. Fredericks' articles. His opinions are thought provoking; however, I respectfully disagree with just about all he has to say. I will hit only the high points.

Fredericks has set out to prove the superiority of a straight stream for interior firefighting. In doing so, he has taken most of his "proof" out of context and degraded its value in the process. He has also totally ignored basic scientific fact. After all, the absorption of heat by water is an endothermic chemical reaction, not just a simple change in temperature.

In the fire service, we use water in one of two ways: to cool the fire down below its ignition temperature or to generate steam to smother the fire. Regardless of which of these two you are trying to do, water will always be used to its best advantage if it is allowed to vaporize. Water that starts out at 68°F will only absorb 144 Btus when heated to 212°F. This is because of the specific heat properties of water. In the process of going from liquid at 212°F to steam at 212°F, a pound of water will absorb another 970.3 Btus. This is the latent heat of vaporization of water. This means that water allowed to fully vaporize will absorb a total of 1,114.3 Btus per pound. By vaporizing, water will absorb more than 7.7 times as much heat than if the water were only allowed to get to its boiling point-or, to put it another way, if we don't allow water to vaporize, we reduce its efficiency as an extinguishing agent by an astonishing 87 percent.

Fredericks is overly concerned with the danger of steam to the interior attack crew. If properly done, the steam generated from an interior attack with a fog nozzle is a non-issue. Since the fog pattern has a unique property, a straight stream pattern lacks the ability to draw fresh air in behind it, the area near the floor around the attack crew remains sufficiently cool to prevent the bulk of the steam from descending on the attack crew. How's that for using the thermal balance in a constructive way?

Since a fog nozzle operating at 100 psi tip pressure and flowing 100 gpm can move as much air as a small window exhaust fan, most of the steam generated will usually be blown out the window of the fire room. This is the reason ventilation needs to be coordinated with the interior attack. Another point to consider about the ability of the fog nozzle to move air is that if trapped persons are not in the immediate area of the fire, the fresh air the nozzle pulls in can increase their chance of survival. Victims in the immediate vicinity of the fire are probably dead anyway if the area has flashed over. Remember, flashover occurs at around 400°F and, as Fredericks points out, unprotected people cannot survive beyond 300°F if the air is dry. We also need to remember that since water vapor is a by-product of combustion, the requirement for dry air is not met anyway.

A point to consider about the information Fredericks uses to support his point is that it is 50 years old. Some of the early concerns have just not proven themselves to be as serious as first thought. The issue of steam burning the attack crew is just such an issue. In the intervening 50 years, interior fire attack with fog has proven to be worth its weight in gold. A combination attack extinguishes the fire with a fraction of the water a direct attack uses. If done correctly, the overhaul crew will not have to clean up water that has pooled on the floor below. This also means companies get back in service faster. In my 28 active years as a firefighter, I personally have participated in at least a few hundred interior attacks-all with fog nozzles and not one steam burn. In fact, I cannot recall any steam burns received by anyone I was ever with. Just one more empirical study that proves interior firefighting with a fog nozzle is as safe as any other form of interior firefighting, and more efficient.

Another point about the use of combination variable fog straight stream (CVFSS), even when doing a direct attack, the fog nozzle can often be more efficient than a straight stream. Instead of having to make several sweeps of the fire, 7/8-inch or 15/16-inch at a time, the fog pattern can be adjusted to cover the entire burning area and extinguish the fire with one pass-again, reducing water damage and getting the most out of the water. And, I haven't yet explained how the fog nozzle can be put on wide fog to protect the line crew when things do go bad.

One other point I would like to make is that the contention that fires are worse today than in the past is trite. I first heard it in 1965 when I began firefighting as a volunteer. They used all the same reasons then as now to explain why fires are worse. I recently had a fire protection engineer make the same statement to me, so I contacted the National Fire Data Center to find out the truth. It turns out that fires today are no worse than they have been since at least 1988. The same percentage of fires was extinguished by tank water and hydrant water from 1988 to 1997. If fires are worse today, there should be an increase in both categories over the 10 years of the data. I would have liked to have carried the data back further to see if or when an increase in severity occurred, but reliable data are not available past 1988. I strongly suspect that any increase in severity because of plastics and the like occurred before the 1970s. In short, it is time the fire service stopped using that worn-out excuse to explain away its inability to positively deal with this nation's increasing fire fatality and injury rates.

Firefighting is a dangerous undertaking. Even under ideal circumstances, just one mistake can injure or even kill a firefighter. CVFSS nozzles are a tremendous asset in our efforts to do the job safely and efficiently. Choosing when to use fog or straight stream requires a thorough understanding of applicable principles of chemistry and physics supported by actual firefighting experience. After all, we must at all times be smarter than the fire and be capable of using all our resources to their fullest to accomplish our goal; our greatest resource will always be our intelligence.

William F. Crapo
Captain (Retired)
District of Columbia Fire Department

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Andrew A. Fredericks responds: I appreciate Crapo's comments and he is certainly entitled to his opinions, but I must respectfully disagree with the entire content of his letter. I do not believe that I ignore basic scientific fact anywhere in my articles. I believe it is just the opposite. Although he provides an explanation of the mechanism by which water absorbs heat-an explanation that should be understood by anyone who has completed a course in introductory fire science-he is evidently confusing efficient steam creation with efficient fire extinguishment. They are not one and the same. Although water fog will convert to steam more readily than a straight or solid stream, much of this steam creation will occur at what might be termed the "nozzle team/fire interface." A straight or solid stream is advantageous in that the steam necessary for fire control is generated largely at the "fuel/flame interface," which is more efficient because it eliminates the production of volatile fuel vapors at their source and is much less debilitating to the nozzle team.

As far as the dangers of steam burns are concerned, my personal experience indicates that excessive unwanted steam production is an issue, and I believe there are many readers who have their own horror stories involving the inappropriate use of water fog during interior fire attack. I remember a particular fire on the second floor of a private dwelling in my hometown. I was a fresh-faced volunteer firefighter and was assigned to the backup line. The first line was bogged down, and the fog stream being used was doing nothing more than causing pain and discomfort to everyone on the stair landing. A senior member of my fire company-and one of the best, most instinctive nozzlemen I've ever met-arrived on the stairs and pushed his way to the top. He simply turned the stream adjustment from fog to straight stream, and in a few seconds the fire was blackened and the line was advanced into the fire room to finish the job. Crapo himself admits that a "narrow trimmed stream allows you to interrupt the combustion process from a fairly safe distance and cool the fire area prior to entry." A "narrow, trimmed stream" sounds like a straight stream (or something very close) to me.

Crapo also mentions air movement and, though a fog stream will both "push" air ahead of the stream and bring air in from behind (not to mention the air entrained in the stream), there is no documentation to suggest that this air is in any way beneficial to victims in the fire area. To suggest that anyone in near proximity to the fire is "probably dead anyway" is a cop-out and flies in the face of what we stand for as a fire service.

With regard to the statement that flash-over occurs at around 400°F, I hope this is a typo, because most members of both the fire service community and the fire protection engineering profession believe flashover begins when ceiling temperatures are in the 750°F to 1,100°F range-generally closer to 1,000°F. [Carbon monoxide (CO) doesn't ignite until it reaches a temperature of 1,128°F.]

Crapo also describes the importance of ventilation when using a fog attack, but to assume that adequate and timely ventilation can always be provided is simply not the case. As far as the contention that a fog stream will protect you when "things go bad" is concerned, apparently he has bought into perhaps the most ridiculous myth in fire service folklore. All fog will do is burn you or burn someone else. I am also aware of several instances when the high-pressure zone ahead of a fog pattern, in conjunction with inadequate ventilation, caused the fire to wrap around the fog stream and burn the nozzle team. A veteran fire instructor at the Illinois Fire Service Institute coined the term "&%$#@ death knob" when referring to fog nozzles and their impact on firefighters.

As far as my supporting documentation's being 50 years old-that's the point. After hearing so many partial truths and outright nonsense about the use of water fog in interior fire attack, I spent the last 10 to 12 years researching this subject in an attempt to place the invention and development of fog fire attack methods into historical context. By reading original manuscripts authored by the inventors of the indirect and combination methods, I hoped to avoid using arguments based on unsubstantiated claims, misinterpreted data, and personal opinion.

Crapo is also preoccupied with water damage. If water damage is a consideration that supersedes prompt fire control and nozzle team safety, tactical priorities are severely skewed. I use the example of an apartment fire on the second floor of a five-story building. Obviously, the issue of water damage in the fire apartment itself is ridiculous-the fire damage will be far greater than any water-induced damage. Perhaps the apartment directly below the fire apartment will suffer some damage as water migrates through light fixtures and the like. But if this fire is not promptly controlled with a hard-hitting stream, consider the alternatives. As the fire burns through the floor of the apartment above (or auto-exposes and enters via the outside), we now have two apartments involved in fire. Smoke generation will continue unabated and fill each of the other apartments on the floors above, jeopardizing occupant life safety. If there are five apartments on a floor, that's 18 apartments between the second floor and the top floor now contaminated with smoke and toxic CO. So in our effort to reduce water damage with a weak, ineffective fog stream, the result is two fire-damaged apartments, 18 smoke-damaged apartments, and maybe a dozen or more people homeless and suffering the effects of smoke inhalation.

In Firefighting Principles & Practices, Second Edition, by the late William Clark, pages 38-41, Clark explains some of the many disadvantages of fog streams, including the fact that during a series of tests, water runoff collected from fires controlled by solid streams was consistently less than runoff collected from fires controlled by fog streams. The fires apparently succumbed to the hard-hitting solid stream more rapidly than the fog streams, using less water overall. In addition, the solid stream attacks were less likely to leave smoldering remains, which require significant follow-up extinguishment and overhaul.

With regard to the issue of the modern fire environment, I am offended that Crapo has trivialized a reality that firefighters in New York City and elsewhere face each day. I, too, had heard statements about fires being worse today than in the past, so I set out to investigate the facts. I consulted with some of the most experienced firefighters and officers in the country, as well as members of the fire protection science and engineering communities, to produce a balanced and objective analysis.

Using data on the percentages of fires extinguished with tank water vs. hydrant water is hardly a scientific approach. Not only are these data subject to error, but in many fire departments, the capacity of booster tanks on engine apparatus has increased by 50 to 100 percent since 1988, making this argument severely flawed. In the mid-1980s, my local fire department had three front-line engines-one with a booster tank capacity of 300 gallons and two with 500-gallon tanks. The fleet now features one engine with a 750-gallon tank and two engines with 1,000-gallon tanks. To say the same percentage of fires is extinguished with booster water vs. hydrant water today as in 1988 does not indicate the amount of water actually used to control these fires and certainly does not provide a true indication of fire severity.

Considering the number of firefighters we've lost in the past several years-many horribly burned due to the volatility of the modern fire environment-it is unconscionable to attempt to trivialize their sacrifices. There is something going on. We all should be striving to help solve the problem instead of denying it.

By the way, I e-mailed a member of the District of Columbia Fire Department (DCFD) and talked to several friends who are present or former DCFD firefighters. They tell me that straight streams-not fog streams-are taught at the fire academy and are used by the busiest engine companies in the department. You might even find a solid stream nozzle or two.

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Reference is made to "Little Drops of Water ... Part 1." I recently met with Keith Royer in Punta Gorda, Florida, and I telephoned him a week ago to confirm what I am going to tell you now. The combination attack is not "designed primarily for exterior application of water." Neither is it true that "many fire departments had few, if any, self-contained breathing masks available." This is certainly not true of the research done at Iowa State University. Keith Royer confirmed to me that the combination attack works equally as well from an inside door or an outside window. He said that they did "an awful lot of interior firefighting." What you are claiming applies to Layman's work only. The videos produced at Iowa State University used an exterior attack exclusively for one simple reason. It would have been impossible to produce any videos of an interior attack.

The claim that in Royer and Nelson's writing there is "no mention of the impact of steam on trapped occupants" is false. I refer you to page 109 of Nelson's book, Qualitative Fire Behavior, the section entitled "Effect of Expanding Steam." Overall, however, Fredericks is to be congratulated on producing a fairly accurate analysis of Royer and Nelson's research. As a matter of professional courtesy, and to eliminate any errors, I don't see why Fire Engineering shouldn't present any articles on Keith Royer to him for review before publication.

With respect to Chief Lloyd Layman, there are two major errors:

1. While it is true that an indirect attack requires holding the nozzle in a "fixed position," Layman did not advocate doing this (see page 48 Attacking and Extinguishing Interior Fires). Layman advocated dispersing the water widely using a high-velocity cone. He advocated a "slight, brisk, and continuous manipulation of the nozzle." He also added "considerable skill and confidence are required to obtain a high degree of dispersion." I think that because of the ceiling height of eight feet, Layman's recommendation was not truly an "indirect attack" but, in reality, a rather crude form of combination attack, using the structures in Parkersburg, West Virginia.

2. With respect to the 1940 edition of Layman's book Fire Fighting Tactics, Layman, after his research on the use of fog nozzles at the Coast Guard Academy during World War II, simply changed his mind about the role of solid-stream nozzles in fighting Class A structure fires. The 1953 edition of this book, page 45, presents a completely different set of principles and suggestions. In fact, Layman stated: "The solid stream will continue to have a limited degree of usefulness in fire-fighting operations, but it is destined to become the secondary form of application." This prediction has come true today.
John D. Wiseman
Training Officer
Kitrell Volunteer Fire Department
Readyville, Tennessee
Author, The Iowa State Story
Fire Protection Publications
Oklahoma State University

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Andrew A. Fredericks responds: Wiseman and I have not seen eye to eye on several issues in the past, but I am glad he found my article accurate. I agree that I should have sent a draft copy to Keith Royer; that is my mistake. As far as Wiseman's specific points are concerned, I did not include the late Floyd Nelson's book Qualitative Fire Behavior in my research for Part 1 because it came many years later. I do have a reference to it in Part 2.

With regard to the "two major errors" contained in my article, Layman does indicate on page 48 of Attacking and Extinguishing Interior Fires that a "slight, brisk, and continuous manipulation of the nozzle" might be required to obtain efficient dispersion of the water fog. It is far less nozzle movement, however, than is necessary with the combination attack, which requires rapid, almost violent, movement of the nozzle.

Regarding the second "error," I included reference to Layman's 1940 text because so few members of the fire service know it exists. Additionally, direct attack was still advocated by Layman under certain circumstances, even after water fog came into vogue. Fires in the first phase or early second phase of development may not generate sufficient heat to make an indirect attack efficient. Likewise, a building containing a well-advanced fire venting to the outside through numerous failed windows is no longer a candidate for indirect attack. In these instances, a direct attack is preferred (see page 40 of Attacking and Extinguishing Interior Fires). As far as the direct attack's becoming the "secondary form of application," quite the contrary is true. It is the principal form of fire control practiced by the best and busiest fire departments.

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I have read the excellent articles by Andrew A. Fredericks. I must say that despite the fact that Elkhart Brass provided the photo, it is not the original Mystery nozzle. The original did not have the teeth around the opening. It was like an overgrown garden hose nozzle. It provided a huge airflow in the center. The Navy rejected it out of hand, since it could not handle the applicators the Navy wanted. One manufacturer submitted a nozzle with three different straight tips and a fog tip that could be removed to put in an applicator. It had all sorts of locking levers. If you want a good hydraulic smoke mover, take the teeth off a Mystery-type nozzle.

There was a box of such stuff at the Fire School at Norfolk, where I was assigned in April 1944 after two years in Panama and where I commanded a Class B school. Lieutenant Jim Allen (lieutenant 6 Truck, later a DC), who was there as a ship fire inspector, "buffed" at my fire school. He had been to the Boston school and was familiar with the topside use of fog on the engine room compartment. He wanted to try it on my smaller structure in Panama. I told him it wouldn't work. There was no exterior platform on which to stand safely. He insisted. As I predicted, the flames came out the voids between the railroad rails that supported the loose plates (held by vertical pins in holes in the plates). I had told him he could only try this if he stood right at the vertical ladder. He was happy to bail out.

At Norfolk Fire Fighting School, we had a stubborn fire in the engine room. I finally bounced a straight stream off the steel and got it out. Some accused me of heresy. I said, "You saw fog made at a point distant from the nozzle."
Francis L. Brannigan, SFPE
Port Republic, Maryland

Fire Engineering
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CONSIDERATIONS FOR THE EFFECTIVE USE OF DECK GUNS

BY JIM REGAN AND ANDREW A. FREDERICKS

The most potent weapon in any fire departments arsenal is the master stream. By most definitions, any stream greater than 300 gpm and that requires mechanical assistance for handling is defined as a "master" stream. Some texts use 350 gpm as the threshold between handheld hoselines and master streams (consider that a 2 1/2-inch handline with a 1 1/4-inch tip will flow more than 350 gpm at 50psi tip pressure), but the difference is academic.

Also called "large caliber streams" or LCS, these long-reaching, high-volume streams may be portable (sometimes called "ground-based"), elevated (including ladder pipes and nozzles attached to elevated platforms), or mounted atop the engine apparatus itself. Although engine companies may be required to supply any of these devices, this article is concerned with the latter category.

DECK PIPES AND DECK GUNS

By traditional definition, a deck pipe is a fixed appliance with no preconnected source of supply. It must be fed by a pumper. In an earlier era when two-piece engine companies were standard, the first piece was a hose wagon. The "wagon" was equipped with hose, nozzles and a deck pipe (also called a "turret pipe" or "wagon pipe") and would take a position near the fire building. The second piece-a pumper-would take water from a nearby hydrant and supply the wagon. Even many early triple combination engines featured true deck pipes- entirely separate from the pump itself.

Note that the installation of deck pipes has not been limited to engine apparatus. Many water towers (used extensively by major metropolitan fire departments throughout the first half of the last century) were equipped with deck pipes to augment their mast-mounted nozzles. Several fire departments-mostly in New England-operated tractor-drawn aerials with deck pipes mounted on the tractor or trailer. Tower ladders have also been equipped with deck pipes, taking advantage of the superior positioning options these apparatus are afforded at large fires.

Since true deck pipes an independent source of supply, they often prove too limiting from a tactical standpoint. Instead, most engine apparatus today are equipped with some type of preconnected appliance, which may be termed a "deck gun." Various types of deck gun nozzles exist. In some arrangements, it is actually a portable deluge gun (sometimes called a portable monitor or "multiversal") mounted on a deck or platform and supplied by the pump using short lengths of preconnected hose. In other arrangements, it is a combination fixed/portable appliance, which is attached to a bracket on the cab roof or above the pump. It may be used from this position or removed and used as a portable monitor. For most of these devices, the flow range is much more limited when used as a portable nozzle.

On many contemporary engine apparatus, the LCS are supplied directly from the pump by a 2 1/2 or three inch pipe (a so-called "pre-piped" deck gun). The Fire Department of New York (FDNY) currently uses this style of deck gun. For decades, the FDNY used only combination/fixed portable appliances carried atop the engine cab above the pump. If the need for a portable large-caliber stream arose, the device was detached from its bracket, handed down to firefighters on the ground, and carried to the point of operation. This procedure was cumbersome, and it was decided that using two separate appliances could increase efficiency. Since 1992, FDNY engines have been equipped with both a prepiped deck gun and a portable LCS device, which is carried in a readily accessible compartment on the apparatus.

SAFETY CONCERNS

The excessive average height of modern day engine apparatus combined with topside storage arrangements that leave little room for a firefighter to operate the deck gun creating numerous concerns from both a safety and operational standpoint.

Modern apparatus design is rarely concerned with the physical limitations of the average firefighter and the small crew size of most fire departments. Often the hosebeds are impracticably high and difficult to reach, as is the deck gun. Consider the effort involved in climbing six or eight feet up the side or rear of the apparatus in protective gear and self contained breathing apparatus just to reach the deck gun. The danger of slipping is very real and is compounded by the motion restrictions imposed by bunker gear, an altered sense of balance caused by the SCBA cylinder, and the relatively small size and poor placement of the steps provided for climbing.

Once the firefighter reaches the top of the engine, stored foam containers, rolled up lengths of hose, and other assorted tools and equipment often make operation of the deck gun as formidable a challenge as the climb to reach it. Many engine companies lack large, nonskid decks or platforms that allow a firefighter to operate the deck gun safely and effectively in any direction. This may place the firefighter in a precarious position-particularly if the deck gun is mounted in an offset fashion-and increase the risk of a misstep and possible fall.

If climbing up isn’t dangerous enough, consider the difficulties involved in climbing back down. The risk of a fall resulting in a serious injury while fishing around in the dark for a poorly lit, ice covered step is a real concern.

OPERATIONAL PROBLEMS

Not only does the height of modern engine apparatus make using the deck gun difficult and dangerous, height also impacts the deck gun’s tactical effectiveness. On some occasions, the height of the cab prevents use of the deck gun toward the front of the apparatus. The desire for the crew cabs that permit firefighters to stand has proven to be a very limiting factor. While creative apparatus placement can overcome some of these limitations, on many occasions use of the deck gun is eliminated entirely. Other designs (oversized water tanks are often the culprit) limit use of the deck gun toward the rear of the apparatus or on the officers side where the hydraulic ladder rack is usually installed.

One solution to the problem of overly high cabs and other hinderances to a deck guns operation is an extension/retraction system involving the pipe or riser supplying the deck gun from the pump. Such a system allows the deck gun to rest in a well or at a level below the cab roof during travel but permits 360 degree operation of the device at fires. We have several concerns with these devices, and they have been used in configurations not recommended by their manufacturer, pointing out potential operational problems. Plus, it’s just one more thing to break or fail when you need it most.

Another problem with deck gun nozzles that sit as much as nine to 10 feet above the ground is a dramatic loss of effectiveness at low-angle operations. Consider an engine company arriving at an early morning store fire with a total of three personnel. The store is 35 feet wide and 100 feet deep. The fire has possession of the entire sales area and is starting to vent from the storefront windows.The fire store sits on the ground floor of a three-story building in the middle of a crowded block. There are two other businesses on each side of the fire store and occupied apartments on the second and third floors. One excellent tactic for this first-due engine company is to immediately discharge its booster tank water through the deck gun to quickly knock down the heavy body of fire.

Taking into account the positioning limitations imposed by a narrow street combined with the excessive height of the deck gun above the ground, most of the water will be wasted as the stream hits the floor only 25-30 feet inside the door. Without significant penetration of the stream into the store, the fire will continue to grow unchecked.

Still another limitation relates to the type of tip used on the deck gun. Solid-stream tips are absolutely required to maximize effective reach and penetration without premature stream disintegration from high temperatures, thermal currents or wind conditions. Remember that stream appearance can be deceiving. Many fog tips produce streams that look trim and tight but may not necessarily pack sufficient volume and penetrating power. This becomes a critical factor considering the superheated fire areas the stream must penetrate and the need to reach the seat of the fire, even when the engine must be positioned a safe distance away because of the radiant heat.

Tip size is another factor. The smallest tip that you should normally use on a deck gun is 1 3/8 inches in diameter (see the exception below), which will produce a flow of approximately 600 gpm at a tip pressure of 80 psi. Many stacked tip combinations for LCS nozzles include a 1 1/4 inch tip. This is a handline tip, and you should not normally use it on LCS devices. Whenever available water supplies are sufficient, use the largest tip possible. Large fires with severe exposure problems demand tips at least two inches in diameter, which translates into a flow of more than 1000 gpm at 80 psi tip pressure.

CHICAGO'S LONG DECK GUN

As discussed earlier, a hard-hitting attack (sometimes referred to as a "blitz" attack) using deck guns or high flow handlines can be highly effective. Many departments have adopted one variation or the other to achieve fast knockdowns. In 1976, Captain William Olson of Chicago (IL) Fire Department Engine Company 39 began experimenting with a preconnected deck gun mounted atop a newly assigned engine apparatus. Originally equipped with a 1 1/2 inch diameter outer tip, Olson modified his nozzle by replacing the 1 1/2 inch tip with a 1 1/8 inch tip and a Chicago "street pipe." This produced a more effective stream and a longer duration operation when using booster tank water.

Engine 39 was very successful in controlling large amounts of fire using its deck gun. One particular fire with fully involved wooden porches on the rear of an apartment building was knocked down using only the water contained in the booster tank. Critics who said the tactic of using a deck gun at fires in occupied buildings would drive fire throughout the structure were proven wrong. The key to success was in the specific techniques employed when using the deck gun. Rather than a prolonged blast into the "heart" of the fire (as would be called for once defensive tactics were implemented), personnel directed the stream at the ceiling of the fire area for only 30 seconds or so-just long enough to darken down a heavy body of fire.

Olson later transferred to Engine Company 116, where these tactics were refined further. In 1979, Olson was promoted to battalion chief and was assigned to Chicago's South Side, where he and Captain John McNamara of Engine Company 61 began using the deck gun and preconnected 1 3/4 inch lines with great results.

The techniques initiated by Olson and McNamara were refined and developed into a standard operating procedure that became known as "Quick Water." Using four inch supply hose, prepiped deck guns, 1 3/4 inch preconnected handlines, and low-pressure combinations nozzles, "Quick Water" supplanted traditional "reverse lay" procedures in the early 1980's.

HOUSING PROJECT FIRES

At about the same time as the introduction of "Quick Water", Engine 61 began experiencing another type of fire problem. Its first due response area includes one of the highest concentrations of public housing in the United States. Although built of fire resistive construction, these buildings posed difficult fire problems because of standpipe systems out of service as a result of vandalism or winter weather. This presented a real obstacle in getting water to the upper floors of these 16-story buildings. In addition, many apartments were vacant and becoming hangouts for street gangs, increasing the incidence of incendiary fires. With so many hurdles for personnel to overcome, the time required to place a handline into service often allowed fires to spread into the public hallway or extend by autoexposure to the floor above.

McNamara and Lieutenant Patrick Durkin decided that one means of controlling a growing fire on an upper floor in a building with a disabled standpipe system was to use the preconnected deck gun. The goal was to direct a quick application of high-pressure water through the window to knock down the heavy fire while other members were getting a handline into position by whatever means available. Faster fire control means increased life safety for civilians and firefighters. But what about the apartment door? An open door-even if only partially so-will cause conditions in the public hallway to deteriorate rapidly as the stream drives heat and smoke from the apartment.

While this would normally be a critical issue, several extenuating factors were at work that tempered the risks. First, this technique was designed for upper floor fires as a means of overcoming standpipe vandalism and other problems. The stream angle at upper floor operations reduces the chances of "pushing" the fire throughout the apartment and into the hallway. Most of the water strikes the ceiling of the fire apartment and coarse droplets rain down on the burning contents. Second, the delay in water application caused by the aforementioned problems often resulted in extension to the floor above and injuries to the occupants of other apartments on the fire floor as heat, smoke, and toxic carbon monoxide filled the hallway. Third, employing a smaller tip than normally used with a deck gun and limiting the application of water to only a few seconds further reduced the danger of forcing the fire from the apartment of origin. This latter point (tip size) was one of the key problems that had to be overcome for this technique to be effective. The design of the deck gun in conjunction with the standard tip sizes available would not produce a stream that could be used for upper floor fires. The prescribed nozzle pressure of 80 psi (typical for solid master streams) simply would not produce enough velocity pressure to overcome gravity; "overpressurizing" the deck gun caused a significant deterioration in stream quality and its consequent loss of effectiveness.

To solve these problems, Durkin conceived the idea of attaching a Chicago "street pipe" (similar in design to an Underwriters Playpipe in that it has a long, smooth, tapered barrel but also incorporates vanes to further reduce stream turbulence) to the end of a long stream straightener. A 1 1/8 inch tip was selected to generate the high velocity pressure necessary for reach and to conserve water during booster tank operations. The stream developed using this arrangement was significantly better than one produced using either the "street pipe" or the deck gun stream straightener alone. (For more information on developing high quality solid streams, see our article "Improving the Quality of Your Solid Streams" in the April 2000 issue of Fire Engineering.)

When supplied with a nozzle pressure as high as 185 psi, the stream retained good quality and could reach the roof of the 16-story project building. Flowing approximately 500 gpm for a duration as short as 10 to 20 seconds applied a manageable amount of water, achieved rapid knockdown, and permitted lines to be placed into position for a safe advance. Other benefits of this arrangement included the ability to perform "hydraulic" ventilation of upper floor windows including those covered with plywood.

It should be obvious that such a tactic requires training and coordination and is certainly not suitable for every fire. Whenever possible, delay the use of outside streams until you can close the apartment door. At a minimum, communication between the attack crew and the pump operator is essential to ensure the handline advance does not begin while the deck gun is in operation.

It should also be noted that the long deck gun has been used with excellent results during purely defensive operations. The smallest tip normally employed with Chicago's deck guns is 1 3/8 inches in diameter, which produces a flow of about 530 gpm at 90 psi. As noted above, with the "street pipe" and 1 1/8 inch tip attached, the gun will flow about 500 gpm when pumped at 185 psi-slightly less water-but the stream will easily penetrate to the heart of the fire and will rapidly break window glass and pierce plaster walls and ceilings.

FIREFIGHTER RESCUE

Outside streams have often been employed during civilian and firefighter rescue efforts and have saved many lives. As described in "Engine Company Support of RIT/FAST Operations" (Fire Engineering, April 1999), the rescue of a Detroit captain trapped at a third floor window was made possible by a deck gun stream used to drive back the advancing flame front. The article also pointed out how the use of a 2 1/2 inch by 2 1/2 inch gate valve attached to the deck gun on the appliance side of the stream shaper gives the pump operator greater flexibility in firefighter (and civilian) rescue operations by allowing absolute control over the quality and duration of the stream.

Situations in which a firefighter is trapped above the ninth or tenth floor and beyond the reach of aerial ladders and elevating platforms are especially difficult and dangerous. This is where the long barrel deck gun can prove advantageous. The ability to throw a stream of water as high as the 16th or 17th floor may save the trapped firefighter from the horror of choosing between jumping to death or burning to death until an interior or rope rescue attempt can be mounted.

Chicago's Engine Company 61 still uses the long barrel deck gun. It is the product of innovative fire officers seeking solutions to difficult and unique firefighting problems.

EXPOSURE PROTECTION

One of the arguments against using solid-stream tips for exposure protection is the inability to switch to a narrow fog pattern and provide a protective spray. While this argument has some merit, consider the following: First, a narrow fog pattern lacks the reach of a solid stream and may fall short of the target or will be carried away by the wind (fog master streams-even many straight streams-perform very poorly even in a moderate breeze). Second, the heat from the fire may vaporize the water, or thermal currents will carry it away before it can do useful work. Third, splattering a solid stream against a wall will permit the water to cascade down the face of the wall, providing the most effective means of absorbing radiant heat energy from an exposing fire. Water streams' lack of opacity makes the use of spray curtains all but useless. Splattering the stream in this fashion will also provide relief to any firefighter exposed to heat and flame if a direct hit on the fire is not possible.

OFFENSIVE ATTACK

Deck guns can be successfully employed in conjunction with other offensive firefighting tactics. Consider the following example: Several years ago, FDNY Engine Company 48 arrived first due at a fire involving five attached two-story occupied wood houses with flat roofs and a common cockloft. The fire had started outside in some rubbish and had extended to the building. On arrival, members found that the wood sheathing on the exposure four sidewall was on fire and the fire had already extended into both the first and second floors through the windows in an exposed shaft.

Engine 48's veteran chauffeur positioned the apparatus so the deck gun stream could be trained on the burning sidewall to darken down the outside fire and limit further extension to the interior. Three lengths of 1 3/4 inch hose were stretched to the front entrance at the same time the booster tank water was being discharged through the deck gun. The second due engine assisted in establishing a positive water supply; the handline was advanced inside and controlled the fire on both floors as well as significant fire extension in the cockloft. Coupled with aggressive truck work, this simultaneous deck gun and handline operation was responsible for saving five homes.

SHIFT IN STRATEGY

One of the most dangerous times on the fireground is when an offensive firefighting strategy is failing and a switch to a defensive strategy is ordered. During the transition phase from an offensive to a defensive operation, the potential is great for severe firefighter injuries. The possibility always exists that some firefighter or team of firefighters will not receive word on the pending change in strategies and will be subject to extreme punishment once large caliber streams are place in operation.

Large caliber streams can cause injury in several ways. They can dislodge pieces of the fire building and send dangerous projectiles traveling at high rates of speed significant distances. The air movement that accompanies high-volume, high-pressure streams can violently displace combustion gases, heat, and smoke and drive them toward unprotected firefighters. The hydraulic force of the stream (or streams) pounding the building may precipitate a localized collapse. In addition, the accumulation of thousands of gallons of water in a fire-weakened building is a serious problem. Not only might the runoff water collect on the floor, but large amounts of it can be absorbed by building contents and by parts of the building itself, most notably insulating materials, carpets, gypsum board, and plaster.

With so many dangers, communication is vital. Remember that communication is a two way street. Without an acknowledgement by the message recipient, do not assume that any order has been received, let alone understood. Even for a short-duration blast of a deck gun stream to save a firefighter trapped at a window, put out an urgent radio message over the fireground frequency to warn other firefighters of the action about to be taken. This gives those firefighters in the most vulnerable interior positions a moment or two to close a door or retreat to the floor below.

TIPS AND SUGGESTIONS

-One FDNY engine company in the South Bronx uses a 1/2 inch “overhaul” tip on its deck gun to combat brush fires along highways. The small tip produces incredible reach; utilizes much less water; and has enough velocity pressure to burrow into the ground and extinguish deep-seated fires involving leaves, mulch, and rubbish.

-Many times, the operator of a deck gun will have difficulty aiming the stream accurately. A radio equipped “spotter” may be required.

-Many firefighters lack the necessary hands-on experience to operate a deck gun. Gain practice by using it for dumpster fires; large outside rubbish fires; and even brush fires as described above.

-To develop a stream capable of reaching an upper floor window, increase the engine pressure before charging the deck gun (according to veteran engineers in the Chicago Fire Department, between 130 and 150 psi works best). This will ensure that more water reaches the target instead of being wasted, as would be the case if the deck gun were charged first and then the pump pressure increased to the required level. This is critical when using booster tank water.

-It cannot be said enough-you normally should not direct large caliber streams into occupied residential buildings. Fire above the ninth or tenth floor in buildings with nonfunctioning standpipe systems or situations involving trapped firefighters, however, are not “normal.”

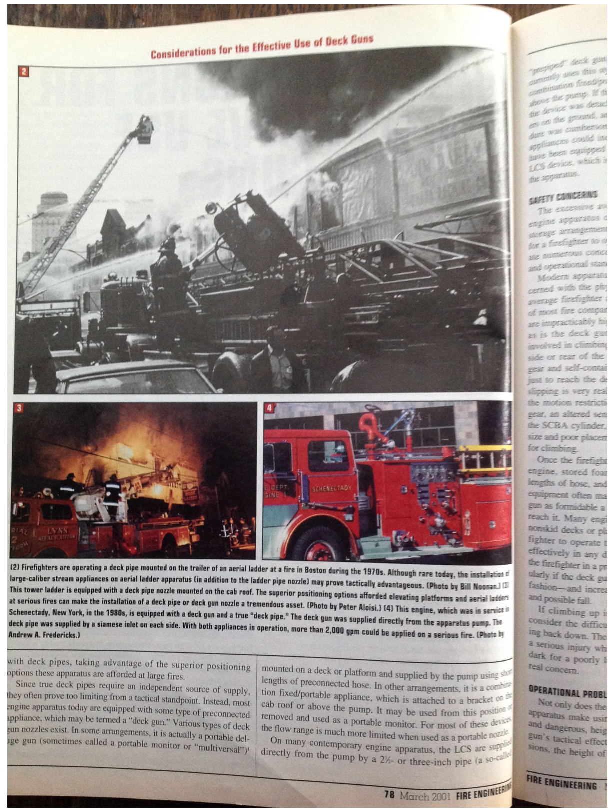
-Several high-rise building fires over the past 20 years have required large caliber elevated streams for control. Do not discount the use of a deck gun in these situations, particularly if a wind condition has halted the advance of interior handlines. Operation of a deck gun stream may knock down enough fire to permit the interior attack to resume.

-Whenever using outside streams, communicating a warning to firefighters in the danger zone is absolutely required!

Deck guns provide the chief in charge of a serious fire with many tactical advantages. Proper design, placement, and training in the use of these devices will expedite fire control and keep civilians and firefighters safe. It is easy to overlook the deck gun sitting high atop the engine, but it should not be forgotten. It may prove the difference between a good “stop” and a multiple alarm disaster.

Thanks to Peter Aloisi, Steve Hagy, Bill Noonan, Battalion Chief Ken Wojtecki, and apparatus expert Tom Shand for their assistance and technical expertise in preparing this article.

Deck guns are one of the most potent weapons that can be brought to bear at a serious fire. Here a deck gun stream is being used to knock down a heavy body of fire in a vacant building in the Bronx, New York. (Photo by Matthew P. Daly.)

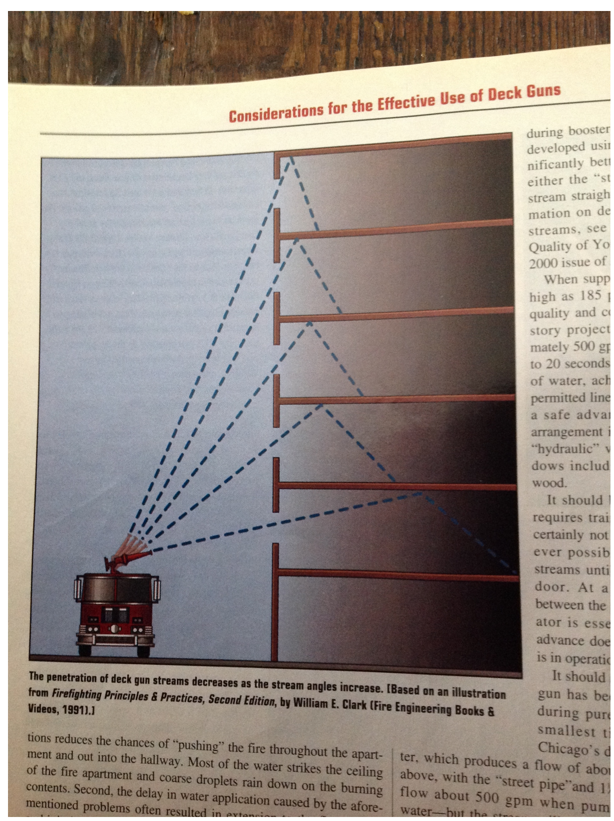


(2) Firefighters are operating a deck pipe mounted on the trailer of an aerial ladder at a fire in Boston during the 1970s. Although rare today, the installation of large-caliber stream appliances on aerial ladder apparatus (in addition to the ladder pipe nozzle) may prove tactically advantageous. (Photo by Bill Noonan.) (3) This tower ladder is equipped with a deck pipe nozzle mounted on the cab roof. The superior positioning options afforded elevating platforms and aerial ladders at serious fires can make the installation of a deck pipe or deck gun nozzle a tremendous asset. (Photo by Peter Aloisi.) (4) This engine, which was in service in Schenectady, New York, in the 1980s, is equipped with a deck gun and a true "deck pipe." The deck gun was supplied directly from the apparatus pump. The deck pipe was supplied by a siamese inlet on each side. With both appliances in operation, more than 2,000 gpm could be applied on a serious fire. (Photo by Andrew A. Fredericks.)

with deck pipes, taking advantage of the superior positioning options these apparatus are afforded at large fires.

Since true deck pipes require an independent source of supply, they often prove too limiting from a tactical standpoint. Instead, most engine apparatus today are equipped with some type of preconnected appliance, which may be termed a "deck gun." Various types of deck gun nozzles exist. In some arrangements, it is actually a portable deluge gun (sometimes called a portable monitor or "multiversal")[1] mounted on a deck or platform and supplied by the pump using short lengths of preconnected hose. In other arrangements, it is a combination fixed/portable appliance, which is attached to a bracket on the cab roof or above the pump. It may be used from this position or removed and used as a portable monitor. For most of these devices, the flow range is much more limited when used as a portable nozzle.

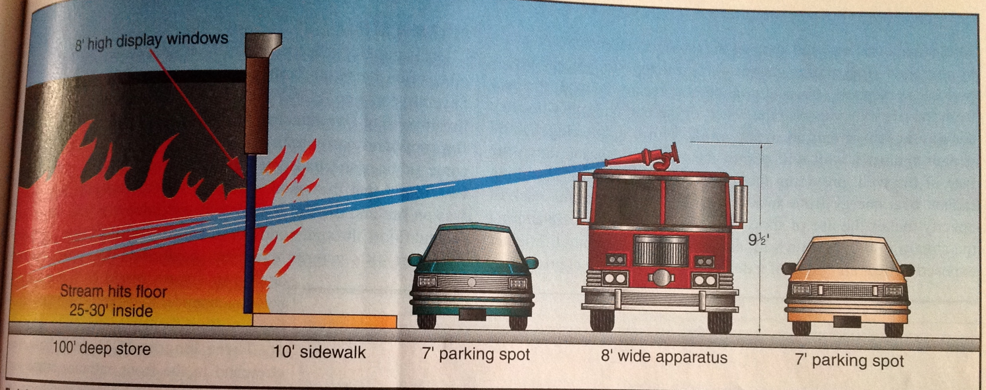
On many contemporary engine apparatus, the LCS are supplied directly from the pump by a 2½- or three-inch pipe (a so-called



The penetration of deck gun streams decreases as the stream angles increase. [Based on an illustration from *Firefighting Principles & Practices, Second Edition*, by William E. Clark (Fire Engineering Books & Videos, 1991).]

tions reduces the chances of "pushing" the fire throughout the apartment and out into the hallway. Most of the water strikes the ceiling of the fire apartment and coarse droplets rain down on the burning contents. Second, the delay in water application caused by the aforementioned problems often resulted in extension

Considerations for the Effective Use of Deck Guns



The height of modern engine apparatus can be detrimental to effective deck gun use. In this illustration, a store fire presents an ideal situation for a quick knock-down using the deck gun stream. Because of the height of the deck gun nozzle above the ground, coupled with the positioning limitations imposed by the one-way street, stream penetration into the store is severely limited. Narrow, two-way streets present the same obstacles. If radiant heat is a problem and the engine cannot position in front of the fire building, stream penetration will be further reduced.

er from the horror of choosing between jumping to death or burning to death until an interior or rope rescue attempt can be mounted.

Chicago's Engine Company 61 still uses the long barrel deck gun. It is the product of innovative fire officers seeking solutions to difficult and unique firefighting problems.

EXPOSURE PROTECTION

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Fire Engineering
March 2002

DEPUTY CHIEF RAY DOWNEY AND LIEUTENANT ANDY FREDERICKS... AS WE REMEMBER THEM

You may be wondering why we're publishing this tribute almost six months after 9-11. Mostly, it's because this was and is so hard for us to write-we just couldn't bring ourselves to do it until now. It's still raw. We're still numb.

Ray and Andy-two of our very close advisors-were very important to us professionally. They spent a lot of time with the Fire Engineering staff, advising, reviewing article submissions, writing articles and scripts, shooting and editing videos, attending and instructing at conferences, and so on. They both were remarkably talented and knowledgeable firefighters-geniuses, actually: Ray, the cool-headed, seasoned commander with 30 years on the job and an awesome, hard-earned national profile; Andy, the intense and firematically passionate younger man who had recently gained national prominence for his brilliant work in fire attack methodologies and who was headed up the FDNY ladder of success.

But it's personally that we're hit the hardest from losing them in the World Trade Center attack. It's hard to accept that Andy won't be walking through our office door to talk tactics with us, to brandish his dry, sarcastic wit-return fire for the good-natured swipes we took at him (after he made Squad 18 we started calling him "Squandy"). We talked for hours about the history of nozzles and fire attack, wrote and rewrote video scripts and 30-page articles that were as demanding as Andy was meticulous. His passion was evident in everything he did, and he did it all for the right reasons. If I had ever mentioned then that Andy was making fire service history, he would have just laughed at me and then resumed the conversation about why smooth-bore nozzles were the only choice for interior fire attack. He was driven to teach (for the Rockland County Fire Training Center; for the New York State Academy of Fire Science; and on the national level, including FDIC) and lay the groundwork for a better fire service. But that drive did not exceed his devotion to his family-Michelle, his wife, and his children, Andrew and Haley.

It's equally as impossible to make ourselves believe that we can't call up Special Operations Command (SOC) for Ray anymore. It was remarkable to us that even as important and busy as Ray was, he always had time for us. We swapped stories about grandchildren and children, we laughed and joked about fire service characters we knew, and we teased him about his "computer under the helmet." He brought us to FDNY SOC, he filled us in on the latest with FEMA or the lessons from last night's big job in New York or about who the real fire service experts were and who was just blowing smoke. He was our mentor, our rescue guru, our friend. On the road, Ray always requested small, intimate dinners with "just the FE gang"-and what special times those were! He could have been out with "the hot shots," but that wasn't Ray-when he wasn't commanding a major rescue operation, he preferred the background. His modesty was as genuine as his God-given ability to lead in crises.

Ray and Andy were part of our family. It's very difficult to get rid of the feeling that each of them had so much more to give, but that's because they both gave so much and there's such a big hole now. They were change agents in the truest sense and made this world immeasurably better because they were who and what they were. This tribute can't fully convey what lies in our hearts for Ray and Andy, but we hope it shows the enduring faith we have that they live on. We hope this gives you a moment to reflect on the greatness in this business. That torch has been passed on to you, to us.

It is only a farewell on the physical level. My friends, they are always with us.

-Bill Manning

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When "God" was on the phone, you made sure to get rid of your other call. They called Ray that-"Rescue God," or just "God," for short. He commanded that level of respect from his Fire Department of New York personnel, from his seminar audiences, from his Fire Engineering readers and staff, and even from his family.

His son Joe, also a firefighter, tells of how members called Joe "Jesus" when he first came on the job as an FDNY firefighter. When he asked why everyone was calling him Jesus, one firefighter replied, "You're the son of God, aren't you?"

To us in his fire service family, Ray's relationship with his beloved wife Rosalie was a match made in heaven (they celebrated their 40th wedding anniversary in 2001 and have five children and nine grandchildren). Of course, when he was captain of FDNY Rescue Company 2, someone at Fire Engineering asked Ray if his wife called him "captain" at home. He replied, "Yeah, she tells me, 'Hey, Cap, take out the garbage." In fact, Ray was so humble that he didn't widely publicize his recent promotion to deputy chief. Jim Ellson, a retired FDNY captain and Downey's right-hand man in SOC, relates that one day he walked into SOC to visit Downey and Downey was grinning from ear to ear. Ellson had to pry it out of him that Downey had been promoted.

In 1994, Ray was promoted to battalion chief and joined Special Operations Command (SOC) a year later. He became the head of SOC in 1997. In 1998, he pushed for the creation of special FDNY squad units with extra training in terrorism response, especially in preparation for the new millennium. He was promoted to deputy chief this past August. Due in part to Ray's diligence, FDNY is one of the best equipped and most prepared fire departments in terrorism response in the world.

When asked how he was able to command complex operations so well, Ray jokingly said it was because he had stored a lot of information in his "computer under the helmet." He was a true, mild-mannered gentleman, but on the job he commanded the utmost respect from firefighters and officers alike. On the scene, Ray was in control. He had what's known as "command presence." In his eulogy at Ray's memorial service, a close fire department friend said he would never forget the image of Ray commanding operations from a tower ladder bucket extended over the water at the crash of TWA Flight 800.

Ray was a former Marine and the most decorated firefighter in FDNY history. He joined the department in 1962, serving with ladder and engine companies and Rescue 2 before forming Squad 1 in 1977. In 1980, he returned to Rescue 2 as captain, where he remained for 14 years. In 1988, he launched the popular column The Rescue Company in Fire Engineering, which not only coincided with his rise to national prominence in technical rescue operations (and which would become the basis for his book of the same name) but helped generate a wave of interest in the area of technical rescue that has continued to this day.

Some of the major incidents on the national and international level for which Ray served as rescue operations commander include the Philippines earthquake (1990), Hurricane Andrew (1992), the World Trade Center Bombing (1993), Hurricane Opal (1995), the Oklahoma City Bombing (1995), the Atlanta Olympics (1996), Hurricane Fran (1996), the Puerto Rico Humberto Vidal Explosion (1997), and the New York ice storms (1998). On the local level, incidents include the US Airways Flight 405 crash (1992), St. George Hotel fire (1995), TWA Flight 800 crash (1996), the 31st Street building collapse (1998), the Times Square scaffolding collapse (1998), the Bronx garage collapse (2000), the Father's Day fire (2001), and the State Street Gas Explosion (2002).

Ray was the USAR task force leaders representative to FEMA for all 28 USAR teams and served on the FEMA Incident Support Team (IST), the advance team that manages federal emergency responses. He spent a great amount of time-including a lot of personal time-making the USAR teams better prepared, trained, and equipped. He was known worldwide as the leading authority on responses to both manmade and natural catastrophic events. For years, Ray had been warning the fire service community and the federal government that, with respect to a major terrorism incident on U.S. soil, "It's not a question of if, but when." In fact, Ray served on the Gilmore Commission, a congressional advisory panel that issued a report last year entitled "Toward a National Strategy for Combating Terrorism."

Downey would have been 64 on September 19, 2001. He was due to retire this year but wanted to stay on in hopes that his son Joe would be made chief. They would have been FDNY's first father-son chiefs.

Ray's dedication to training was evident: In between responding to disasters worldwide, training FEMA teams, testifying before Congress, and spending time with his family, he always found time to teach at FDIC and FDIC West.

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Andy said his late father was the one who sparked his interest in firefighting. But his passion for fire attack methodologies in particular was triggered after he received steam burns while making an interior "combination" fire attack with a fog nozzle, as was typical procedure for the Virginia fire department Andy worked for at the time, prior to his getting on the job in New York. He turned his serious intellectual skills (evidenced in part by his two bachelor's degrees and master's degree in fire protection management) to the application of water on interior fires and soon would develop the nickname "Andy Nozzles."

Andy's initiation to the national firefighting stage was an auspicious start. His first work for Fire Engineering, "Return of the Solid Stream," was published in 1995 as part of a three-article package called "Fighting Fire with Water." The other two articles in the package were written by none other than William E. Clark and Keith Royer, two giants in fire service history and firefighting methods. For Andy, this was a harbinger of greatness to come. Though Andy's life was cut short as he was nearing the height of his career, in six short years he established himself as an industry giant in his own right.

In 2000, Andy delivered a riveting keynote speech, "Don't Worry 'bout that Nozzle, Kid, 'cause We Don't Do Fires Anymore," at the Fire Department Instructors Conference Opening Ceremony. "Firefighting today still remains largely a gritty, up-close, personal affair using tactics and techniques that date back decades," he said. "Even in the high-tech battlefield of today, it is the soldier with the rifle who still makes the difference in wartime. So until we make greater strides in the fire prevention and fixed suppression arenas, the firefighter and his nozzle will continue to be the difference between life and death for literally thousands of Americans threatened by fire every year."

The three videos Andy developed for Fire Engineering, Advancing the Initial Attack Handline (1997), Stretching the Initial Attack Handline (1998), and Methods of Structure Fire Attack (1999), inarguably are the finest and most comprehensive works ever developed on engine work in the video training genre. But Andy's brilliance showed through in all types of training venues, be it at the podium, on the training ground, in print, or on video. He was working on a book on engine company operations, which he saw as the culmination of his life's work to date, at the time of his untimely death at the World Trade Center.

His opinions truly were deep-rooted-and he was not shy about expressing them. "To me, the fire service is still dirty hose and brass nozzle tips, seasoned firefighters who know what it means to pull a ceiling and know what to do when they're told to trim a window ellipse and it's about chiefs who trust their instincts and exude that command presence," he said.

"I view the two-in/two-out rule as a copout standard," he opined to a broad national audience, with searing logic that was a Fredericks trademark. "When the two who are in are in trouble, what are the two who are out going to be able to do? My experience is that it may take a half dozen or more firefighters ellipse to rescue just one firefighter in distress ellipse. To me, the safest way to operate if there are only four personnel available for interior firefighting, I think, is all four in. And the reason is that the search for victims will be completed much more quickly, but most important, water will be applied to the seat of the fire in a shorter time frame, which eliminates all the hazards the two-in/two-out rule was created to address in the first place."

Andy had a reputation for being a devoted family man. There was one time when a deadline for writing one of his video scripts was fast approaching. When he was called and reminded to get his video script finished, his wife picked up the other phone extension and chimed in, "As soon as he paints our kitchen cabinets he can finish the script!" He painted those cabinets.

An indication of the respect the fire department and the City of New York had for Ray Downey: In July 2001, Mayor Rudolph Giuliani held a dinner at Gracie Mansion in Downey's honor.

Speaking at a firefighter's funeral a few weeks before the September 11 tragedy, Ray said, "We have to accept this as part of the job. Sometimes in this job, goodbye really is goodbye."

"People ask me, am I old school?" Andy said, though he entered the fire service as a volunteer in 1979 and was only 40 years old at the time of his death. "I guess in many ways I am, because I truly believe that tradition is important to the long-term survival of the fire service."

Andy was a nozzleman, heart and soul. He had made the decision to get back to his roots and was seeking a detail back to the engine company.

"The garbage man doesn't get excited when he turns the corner and sees trash, because he's expecting it. Likewise, you should be expecting fire on every run."

Fire Nuggets

March 2000

HANDLINE SELECTION

BY ANDREW A. FREDERICKS

Stretching and operating the first handline at a serious fire is the key to saving lives and constitutes the very essence of the fire department's mission. The effectiveness of the first handline as a lifesaving tool is dependent upon several factors.

Simply put, it requires stretching the correct diameter (size) hose to the correct location in the correct amount as quickly and efficiently as possible.

We will concern ourselves here with the first factor—selecting a handline of the correct size.

Handline selection decisions occur on two levels. First-level decisions are strategic in nature and concern what sizes and amounts of attack and supply hose to carry on each engine apparatus. Decisions at this level require an understanding of community risk characteristics including predominant building types, occupancy hazards, height and area considerations, lot sizes, set backs, and hydrant spacing. These factors must be measured against average response times (which impact fire growth) and engine company staffing levels (larger handlines are more difficult to stretch and operate with fewer firefighters). Existing hosebed capacity may also be a consideration. In general, fire departments equip each engine apparatus with at least two sizes of attack hose: Smaller, more maneuverable 1¾-inch or 2-inch hose for fires involving automobiles and residential occupancies and at least one 2½-inch handline for use when larger flows are needed. (The omission of 1½-inch and 3-inch hose was intentional and will be explained below.)

Second level handline selection is based on a size-up of the fire problem once the engine company arrives "at the box." Tactical handline selection is influenced by one or more of the following factors: Fire department standard operating procedures; the nature of the fire occupancy; the amount of fire encountered; the length of the handline stretch; staffing levels; and the practical flow limitation imposed by each of the available handline options.

With the widespread adoption of 1½-inch hose by municipal fire departments after World War II, fireground tactics changed markedly. No longer was larger, heavier 2½-inch hose required for every fire. Coupled with improvements in turnout clothing and the availability of self-contained breathing masks, fire departments everywhere gained the ability to attack residential fires quickly and efficiently from the interior.

But the residential fire environment of the 1940's, '50's, '60's, and '70's was much tamer than it is today. The 60-90 gallons- per-minute (gpm) flows typical of 1½-inch hose are now woefully inadequate. A minimum flow of 150 gpm is far safer.

While many residential fires can be extinguished with only 90 gpm and certainly the skill and tenacity of an experienced nozzleman should never be underestimated, 1½-inch hose offers no flow reserve for contingencies. In addition, the friction loss in 1½-inch hose can be significant, requiring a high pump discharge pressure (PDP) and severely restricting handline length.

The use of 1¾-inch hose, pioneered by the New York City Fire Department in the late 1960's, overcame many of these limitations. Not only is the practical flow limit much higher (about 200 gpm versus 125 gpm for 1½-inch), the friction loss per length is much more reasonable.

Consider the following example: A 150-foot, pre-connected, 1½-inch handline with a 100 psi combination nozzle flowing 125 gpm will require a PDP of almost 160 psi. The same flow with the same nozzle through 150 feet of 1¾-inch hose will require a PDP of only 135 psi. At the same PDP used in the first example (160 psi), the 1¾-inch handline will deliver 165 gpm—a 24 percent increase in flow volume.

A more recent introduction is the 2-inch handline. While the practical flow limitation of 2-inch hose is over 200 gpm, in reality there is a significant amount of "unused capacity." It has been suggested that actual fireground flows from 1¾-inch hose average a paltry 110 gpm or less. The reason is that as flow increases, so does nozzle reaction. Particularly for fire departments that employ 100 psi combination nozzles, reaction forces will exceed levels that can be safely and effectively controlled by a single firefighter at flows of only 130-140 gpm. The difference between potential and actual flows is even more dramatic with 2-inch hose. Since the upper-end flows through a 2-inch hose produce rather substantial nozzle reaction forces and make the line difficult to bend, the nozzleman usually ends up screaming for less pressure or the nozzle is partially closed in order to maintain control. As a result, 2-inch handlines often end up delivering less than 50% of their potential capacity. In practical terms, 1¾-inch hose is just as effective, plus it costs less and is easier to handle.

While 150 gpm is adequate for most residential fires, commercial building fires demand a minimum flow per handline of at least 250 gpm. Characterized by large floor areas, high ceilings, and heavy fire loads, fires in commercial buildings require high-volume streams with long reach and superior penetrating power. In order to deliver 250 gpm without excessive friction loss per length, the use of 2½-inch hose is a must.

In addition to fires in commercial buildings, the 2½-inch handline is ideal for large outside fires, heavy fire conditions on arrival (regardless of the occupancy), vacant buildings, buildings under construction, defensive operations, and exposure protection. Although the size and weight of 2½-inch hose make it rather intimidating, with proper training, the right nozzle, and the use of modern, lightweight hose, it can be a highly effective handline, even for understaffed fire departments. Incident commanders must understand the benefit of a single, well-placed 2½-inch handline and should never hesitate to pair together engine companies to ensure its mobility and fire extinguishing prowess.

Although a few firefighting manuals indicate the use of 3-inch hose as a handline, and some fire departments utilize it as a pre-connected "blitz" or "bomb" line, it is too heavy and too large to be used effectively in the majority of fireground situations. Since 2½-inch hose can deliver well over 300 gpm and is smaller and more manageable, the use of 3-inch hose is an unnecessary waste of hosebed capacity and firefighter resources.

It is incumbent upon each fire department to evaluate its hose and nozzle systems using calibrated-flow and pressure-measuring devices to determine actual performance. Feedback from engine company firefighters on issues such as nozzle reaction and stream performance must also be considered when making strategic decisions on what sizes of hose to carry on each engine. This in turn will lead to more informed tactical decisions and ultimately, faster fire control and increased safety on the fireground.

Fire Nuggets

April/May 2000

HANDLINE PLACEMENT

BY ANDREW A. FREDERICKS

Once a handline of the appropriate diameter is selected, the next decision is where to place this critical first line. Keeping in mind that the first handline stretched at a structure fire is the key to saving lives, placement decisions must be based on the need to safeguard building occupants from the encroaching flames and stem the production of blinding smoke and toxic gases as quickly as possible. We will limit this discussion to residential occupancies.

There is a widely held belief that structure fires should be attacked from the "unburned side." This rule most likely stems from the inappropriate use of fog streams in interior firefighting. The short reach of the fog stream combined with the danger of "pushing" fire into uninvolved portions of a structure often dictates that fire-attack efforts begin in the unburned area in order to minimize further property losses. Unfortunately, this approach does not address the issue of civilian (and firefighter) life safety. A more effective method is to attack structure fires directly using the main entrance or front door, regardless of where the fire is in the building.

In practical terms, consider the extra hose that would be required to reach the rear entrance of most residential buildings in your first due area. Even in the case of a relatively small private dwelling, think about the difficulties involved in stretching down a side alley, driveway, or gangway, over fences, under clothes lines, over piles of snow, around parked cars, and past that large and unfriendly dog roaming free in the back yard. Grade-level changes are another factor. The rear entrance door may actually lead to the basement. If the fire is on the first floor, the handline is now one floor below it with a consequent delay in getting water on the fire. Many preconnected handlines will fall short and additional lengths will be required. Rear entrances may also be heavily fortified, particularly in high crime areas. Using the front door is simply more efficient and will save valuable time.

In the case of a one-story private dwelling, the line can be quickly advanced through the front door to the involved bedroom or used to defend the bedroom areas from a fire located elsewhere in the house. In the case of a two-story house or a multi-story building with an open stairway, using the front door permits the line to be placed at the base of the stairs to defend them from a first-floor fire. Keep in mind that an aggressive attack on the fire should be initiated as soon as possible, but the attack must commence from a position that will drive heat, smoke, and flames away from the primary means of egress.

If the fire is above the first floor, the stairs will provide a secure "beachhead" for launching fire attack operations. This will protect the stairway and help limit fire extension from the room or apartment of origin.

In addition to safeguarding the means of egress for building occupants, securing the stairs also protects them as a means of *access* for firefighters assigned primary search duties. This is particularly important for firefighters ascending above the fire. In most private dwellings and many older multiple dwellings, the stairs are often painted or varnished wood and may be involved in fire. They must be extinguished quickly to preserve their integrity. The old adage "save the stairs, save the building" couldn't be any truer.

When a fire is located below grade in a basement, cellar, or sub-cellar, the objectives of protecting the means of egress and quickly extinguishing the fire remain unchanged, but different tactics are required. The first handline stretched at a basement or cellar fire *must not* be used to extinguish the fire. Rather, the first line should be brought to the top of the interior basement or cellar stairs to defend the upper floors against smoke and fire spread.

If the color and temperature of the smoke venting from the basement or cellar indicate a relatively minor fire, the first handline can be advanced down the stairs and the fire extinguished. If the fire is larger, keeping the interior basement or cellar door closed is imperative and the first line will be used to prevent the fire from burning through this door. The second line will be advanced via an outside entrance to extinguish the main body of fire. If the only entrance to the below-grade area is inside the building (as is often the case with cellars and almost always the case with sub-cellars), the first line will have to be advanced down the interior stairs. The second line will then be used to hold a position at the top of the stairs to protect the personnel assigned to the first line and limit fire extension.

Below-grade fires may also permit an exception to using the front door for stretching and advancing the first handline. It may be more expedient to utilize a side door if it provides ready access to the basement or cellar stairs. A proper size-up and knowledge of the residential buildings in your area will provide this information. Generally, the front entrance is still preferable.

Other situations in which the first line would not be immediately advanced to the seat of the fire are rare. One involves a civilian trapped at a window or on a fire escape and the immediate application of water from the outside is required to prevent him from jumping or burning to death. Another is when the fire building is well involved and an exposed building is severely threatened or already on fire. If the original fire has developed beyond the point of safe control by handlines, the first line should be advanced into the most critical exposure. If interior operations are possible in the original fire building, the first line should be brought inside to control the fire. Extinguishing a fire is still the best means of protecting exposures. Even when an interior fire attack is employed, taking a moment or two while still outside and applying water on an exposed building (or even the original fire building, if a severe autoexposure problem exists), will "buy time" until additional handlines can be placed in service. This is a particularly effective tactic when a fire involves one or more closely spaced, wood-frame buildings and handline stretches are short.

Fire Nuggets

June/July 2000

ESTIMATING THE STRETCH

BY ANDREW A. FREDERICKS

We have previously discussed the selection of handlines based on required fire flow and proper placement of the first handline to ensure its effectiveness as a life-saving tool. In this issue we will present several formulas for estimating the amount of hose needed to reach and cover the fire area.

Estimating a handline stretch is a two-step process. Step 1 is to determine the amount of hose needed within the fire building and Step 2 is to determine how much hose is needed between the fire building entrance and the engine. The objective is to have sufficient hose to reach the most remote room in the fire area without unrolling too much hose, which will increase the required pump discharge pressure, as well as the potential for kinks.

Some fire departments—New York City and Detroit among them—do not use preconnected handlines. Rather, they perform reverse hose lays using "static" or "bulk" hose loads. As an example of how a reverse lay is executed, consider a top-floor fire in a narrow, three-story multiple dwelling. Based on the size of the building, the location of the fire, and the initial position of the engine, the nozzle firefighter and officer immediately remove four lengths of hose. (A length is considered to be 50 feet, although some fire departments use 100-foot handlines.) Why four lengths? The distance between the entrance door and the point where the engine initially stops, just past the fire building, is about one length of hose. Three more lengths are needed in the fire building to reach and cover the "railroad flat" apartment on the third floor.

Once the hose needed for the fire building (plus one additional length to reach the building entrance from the street) is unloaded, the apparatus operator (chauffeur or engineer) drives to the nearest serviceable hydrant as additional lengths play out of the hose bed. If the engine is already positioned at a hydrant when the order to stretch is received, the hose needed to reach the fire building is determined by "eyeballing" it. Landmarks such as parked autos, sidewalk markings, building widths, and lot dimensions may be used to gauge the amount of hose required.

The use of preconnected handlines requires that the engine apparatus be positioned close to the fire building (generally within a length or two). Both parts of the stretch—the hose needed to reach the fire building and the hose needed inside the fire building—must be properly estimated. Particularly when engine apparatuses are equipped with preconnected lines of various lengths, deciding which line to "pull" requires a sound foundation in handline estimation. While an extra length of hose is rarely a problem and acts as an insurance policy, not stretching enough hose can be disastrous. Stretching "short" is probably the most common mistake made when employing preconnected handlines.

Obviously, having enough hose to reach the fire building is important, but it is actually the second step in the handline estimation process. The first step is to estimate the amount of hose needed within the fire building and to ensure this amount of hose is removed from the engine. The question then is how do we determine this amount of hose? Since there are many families of buildings that share similar characteristics, developing hose estimation formulas beforehand is fairly straightforward. Generally speaking, hose estimation formulas depend on a building's frontage, depth, and stair configuration.

For small multiple dwellings, the fire floor is the key. A fire on the third floor of a small apartment house would require three lengths of hose. A fourth-floor fire would require four lengths, and so on. This formula may be referred to as the "fire floor formula," and it works well for multiple dwellings with a frontage of 40 feet or less and depths up to about 85 feet.

In the case of large multiple dwellings (up to 100 feet by 100 feet or more), the fire floor formula is adjusted to compensate for the larger apartments, longer hallways, and enclosed stairways. The fire floor is still the key, but another length is immediately added to the hose estimate. This might be called the "fire floor plus one" formula. A fourth floor fire in a large multiple dwelling would warrant at least five lengths of hose within the fire building in order to avoid a "short stretch." If the building has a large lobby, a sixth length would be added in order to reach the base of the stairs from the entrance door.

Some large apartment buildings are divided into wings. Each wing may resemble a small multiple dwelling with its own entrance door and stairway. If this is the case, the "fire floor formula" may be appropriate. Large multiple dwellings may also feature deep exterior courtyards that will necessitate additional lengths. The best way to determine how much hose will be required is to calculate it in advance during drills or a trip to the building specifically for pre-fire planning purposes.

Handline stretches can also be modified based on the presence of a well hole. A well hole is an opening in the center of a stairway that allows a single length of hose to reach from the base of the stairs to the fifth floor. In addition, lines can be stretched utilizing hooks (pike poles) or utility ropes on the outside of the building. Utilizing a utility rope is a particularly effective tactic when the stairway wraps around a dumbwaiter or elevator shaft. Knowledge of your response area is vital.

For private dwellings, between one and three lengths of hose should be sufficient. In the case of both private dwellings and attached "town homes" (sometimes called "row frames"), always ensure sufficient hose is stretched to cover the entire building. Fires in these buildings travel quickly through void spaces and interior shafts, as well as on the outside of the building, which is often covered by wood or asphalt siding.

Hose estimates for commercial buildings can vary widely, but two or three lengths will cover most small retail stores. A rule of thumb is to add the street frontage and the depth of the occupancy in order to obtain a hose estimate. In the case of a hardware store that is 50 feet wide and 80 feet deep, 50 + 80 = 130 feet. This is almost 150 feet, so three lengths of hose should be available for the store. This will account for the necessary bends and turns as the line is advanced.

Like all firefighting operations, planning and training are essential for accurate handline estimation. For years, engine companies in New York City have operated under the credo: "take the time to make the time." A few moments taken before placing a handline in service to ensure the proper amount of hose has been unloaded will pay huge dividends in terms of fire attack safety and efficiency.

Fire Nuggets

August/September 2000

STREAM SELECTION

BY ANDREW A. FREDERICKS

What type of fire stream should be used during interior fire attack? This remains one of the most hotly debated issues in the fire service and to understand why requires that we briefly examine the history of fire attack methods in use since the end of World War II.

Up until the late 1940’s, structure fires were fought directly using solid streams. Although significant experimentation with fog streams had been underway for some time, their role was limited to fires involving oils and other combustible liquids. Then the late Chief Lloyd Layman introduced his “indirect method of attack” as a means of efficiently controlling fires in structures using the cooling and smothering effects of expanding steam. This launched a revolution, and within a short time the fire service was divided into two camps. One continued to advocate the use of solid streams; the other embraced the use of fog and spray streams.

Those who argued for the use of fog streams were further buoyed by the introduction of the so-called “combination attack” in the late 1950’s. Developed by Keith Royer and the late Floyd W. “Bill” Nelson of Iowa State University’s Fire Service Extension, combination attack theory did not necessarily mandate the use of fog streams. Royer and Nelson’s main concerns were the rate of flow in gallons per minute and the efficiency of water distribution within the involved area. The form of the applied water was secondary, but fog stream proponents largely ignored this point.

The 1950’s also saw nozzle manufacturers begin to tout the advantages of their new (and more expensive) fog nozzles. Scanning the pages of *Fire Engineering* and *Firemen* magazines from the 1950’s and 1960’s, one gets the impression that to use anything other than water fog would brand you a tactical dinosaur.

Other influences were at work as well. The insurance industry viewed fog streams as a near miraculous remedy for water damage. Acting with the passion of religious zealots, representatives of various fire insurance rating bureaus managed to convince scores of fire chiefs that the greatest threat on the fireground was not the fire, but rather the water used to control it! By the time the late 1960’s arrived, the majority of fire departments had replaced their solid bore tips with fog nozzles and the ranks of solid-stream advocates had grown desperately thin.

In the last several years, however, the fire service has undergone a rebirth of sorts in how it approaches interior firefighting. Not only have many fire departments abandoned the use of fog patterns during interior fire attack, solid stream nozzles are reappearing on handlines from coast to coast. While I personally advocate the use of solid streams, if a combination (fog) nozzle is the only option, it should be used in straight-stream position. With an adequate rate of flow (at least 150 gpm for residential fires), a solid and/or straight stream will provide for rapid knockdown with less violent disruption of the thermal layering in the fire area. More importantly, the use of solid and/or straight streams can dramatically lessen the risk of burn injuries caused by unwanted and unnecessary steam creation.

What is “unnecessary” steam? We have been brainwashed into believing that fog streams are efficient because small droplets convert to steam more readily than large ones. While a fog stream will vaporize more quickly than a solid or straight stream, does the efficient conversion of these small droplets to steam necessarily equate to efficient fire extinguishment? The answer is no.

The goal of interior fire attack should not be to rapidly absorb heat energy from vapors burning remotely from the seat of the fire, but rather to apply water on the heated solid materials and prevent release of these volatile fuel vapors in the first place. By cooling the mattress, sofa, desk, or stuffed chair burning in the lower portion of a room, the dangers posed by the accumulation of flammable vapors in the upper portion of the room is eliminated.

Another argument against the use of solid and straight streams involves the compactness of the streams themselves. Fog streams are better, it is said, even when being applied directly to the burning solid materials, because the wider pattern covers a much greater surface area. The problem, however, is that many times, little if any part of the fog pattern actually contacts the heated surfaces. Solid streams and straight streams are more likely to reach the seat of the fire because they are less prone to suffer premature conversion to steam or be carried away by convection currents. In addition, their long reach provides a greater margin of safety by permitting stream operations to commence at a safe distance. This is particularly important when a high heat condition makes a close approach to the fire impossible. The stream should be directed “out front and all around” in order to distribute water over the burning materials, using the ceiling and upper walls as baffles to splatter water into areas otherwise difficult to reach and to agitate (not overcool) the burning vapors at the ceiling.

Still others argue against solid and straight streams (solid streams in particular) because they lack the “protection” offered by fog streams. Although the nozzle team may feel secure behind this wall of water droplets, what is occurring on the other side of the fog pattern? Is the fire being driven into remote areas of the building or structure? Is the fire being pushed towards firefighters performing search operations? In many cases, it is the nozzle crew itself that receives steam burns. On still other occasions, the fire is forced over and around the fog pattern, causing burn injuries or possibly jeopardizing the nozzle team’s escape route.

Fog streams have their place, but not during interior firefighting. The safety of both building occupants and firefighters rests on the success of the first handline. An adequate flow volume delivered in the form of a straight or solid stream is the best means of ensuring this success.

Fire Nuggets

October/November 2000

ADVANCING THE FIRST HANDLINE: PART 1 -PREPARATION

BY ANDREW A. FREDERICKS

In the firefighting business, preparation is everything. Preparation includes both regular drills and training to maintain basic skills; pre-fire planning to reduce the number of curve balls thrown at you during firefighting operations; and preparations that take place on the fireground as each important step in the fire attack process is executed. This article will concern itself with the latter — specifically the preparations necessary at the entrance to the fire area in order to ensure a safe, aggressive, and unhindered advance to the seat of the fire.

The first important consideration for the nozzle team is to ensure that at least one full length of hose is available at the entrance to the fire area. More than one length may be needed, depending on size-up or pre-fire planning information, so one length represents a minimum.

The next consideration is how this working length should be "flaked out" for an efficient advance. This depends largely on where the line is to be flaked out (the front lawn of a private house or a small stair landing in an apartment building), the layout of the fire area, and the location and direction of swing (to the left or right) of the entrance door. If sufficient room is available, the line should be neatly flaked out in a series of "S" shaped curves. Sharp bends, which will inevitably lead to kinks, should be avoided. For fires in private dwellings, the line can be flaked out on the lawn, in the driveway, on the sidewalk, or even in the street. Commercial building fires also often permit the line to be arranged neatly outside. Multiple-dwelling buildings, on the other hand, often pose difficulties due to the narrow hallways and small stair landings found in many of these buildings.

The next factor that affects how the line should be flaked out is the layout of the fire area. Will the line be turning left or right after entry? Does a long hallway lie ahead? Does the line have to advance down a set of stairs for a cellar or basement fire? Does the line have to advance up a set of stairs, as might be required for a fire in a split-level house or duplex apartment? If a hard right turn is anticipated, arrange at least part of the first length on the left side of the entrance door. Conversely, a hard left turn would warrant arranging the line to the right of the entrance door. While this is not always possible, the goal is to facilitate the advance and the smooth movement of the handline.

The swing of the entrance door may also be a factor, particularly when the door seals off a hallway leading to another part of the occupancy when it is opened. This is a common arrangement in "railroad flat" style apartments but is certainly not limited to them. If the fire is located in the area "sealed off" by the open door, the line will have to be advanced around the door — a difficult task at best. The nozzle team may have to feed part of the handline into the occupancy in a direction opposite the fire area prior to entry. This will ensure sufficient hose is available for the advance and avoid at least some of the problems involved in trying to maneuver the line around the entrance door (possibly a 180-degree turn).

Once sufficient hose is in place, the door to the occupancy can be partially closed and the line advanced to the fire. When space is at a premium, where to put the uncharged handline can be a problem. Apartment buildings with small floor landings may require the line to be flaked out on the floor below or on the stairs leading to the floor above. When flaking the line out on a staircase, make wide turns around the newel posts, but avoid pushing the line into the corners where kinks can form. Flaking out the line on the floor below, while sometimes unavoidable, increases the difficulty of the advance because many times staffing is short and there may not be a firefighter available to feed hose up the stairs to the advancing nozzle team.

Often the best option is to flake the line out in an apartment adjacent to the fire apartment or, better still, in one across the hall. Never drape a loop of hose out of a window in order to avoid congestion on the landing. Not only does each 50-foot length of 1¾-inch hose weigh some 80 pounds when charged, a severe kink will form at the bottom of the loop.

Another effective action prior to advancing into the fire area is to take full advantage of whatever visibility exists below the smoke layer. Once the nozzle begins operating, most, if not all, visibility will be lost, so this opportunity must be seized early. In some cases, it may mean lying on the floor and directing a handlight beam into the fire area. The floor layout will be at least partially revealed, and sometimes the exact location of the fire discovered. The glow of the fire may be visible or just the shimmering reflection of the flames on a tile or hardwood floor. Either way, the advance will be much more efficient.

Another reason to look below the smoke is to increase safety. Hazards such as extension cords, sharp objects, and holes in the floor will be discovered and injuries avoided. Utilizing the visibility available at floor level is also very effective during primary search operations. At one fire, a firefighter scanning with his handlight prior to entering the fire apartment noticed a hand dangling below the smoke layer. He told his officer he was going to make a beeline for the hand and quickly discovered two children overcome on the living room couch. His officer found their mother, and the three victims were all successfully removed to the outside just as the fire entered the living room. If a few moments hadn't been taken to look below the smoke with the light, the search would have taken longer and perhaps the end results would have been different.

For fires in multiple-dwelling buildings, taking a quick look at another apartment can provide a wealth of valuable information. This might be an apartment on the floor below the fire (apartments in the same vertical line generally have the same layout from floor to floor) or an apartment adjacent to the fire apartment. Apartment units that are located side by side, particularly in older apartment buildings and garden apartment complexes, often have floor layouts that mirror one another.

More next time.

Fire Nuggets

December 2000/January 2001

ADVANCING THE FIRST HANDLINE: PART 2

BY ANDREW A. FREDERICKS

In the last installment, we left off with the line flaked out and ready for water.

At this point, the nozzle firefighter should be crouching or kneeling on the hose behind the nozzle to prevent the nozzle shut-off from being inadvertently and unknowingly opened. Staying low and to the side of the door also protects the nozzle firefighter and other members of the nozzle team from venting heat, flame, and smoke and affords each firefighter much better control while donning gloves, face piece, and hood. The nozzle firefighter should tuck his helmet between his legs to prevent some clumsy “truckie” from inadvertently kicking it down the hallway or off the front porch and into the snow. All personal protective equipment should be quickly double-checked to ensure proper fit before the line is moved.

In the case of preconnected handlines, either the last firefighter in the stretch or the pump operator must ensure that all the hose has been removed from the apparatus. Charging a handline with hose remaining in the hosebed is not just embarrassing — it costs valuable time, which in turn increases the risks faced by the fire-attack team. As the last firefighter moves forward toward the nozzle, he must ensure the line is not stuck under any automobile tires, fence gates or doors, which will effectively become hose clamps once the line fills with water. The officer (or designated firefighter) can now call for water. As the line fills and is bled of trapped air, the second (and third) firefighters, if available, can don their face pieces and protective hoods, and make final adjustments to their turnout gear and SCBA. Once the line is charged and bled, everyone should be ready to advance.

The act of bleeding the line warrants some additional discussion. Besides exhausting the air trapped in the hose, opening the nozzle briefly prior to the advance verifies that the line is properly pressurized and a satisfactory stream is available. If the pump operator (or engineer) hasn't placed the engine into pump gear or hasn't throttled up yet, it will be quite evident when the nozzle is fully opened and an ineffectual stream results. Radio communications should quickly remedy the problem and the advance can proceed. If the problem is not at the engine, kinks in the handline may be the cause of the poor stream and will have to be straightened.

All members of the nozzle team should be positioned on the same side of the handline. Ideally, when at least two firefighters are available, the second (or “backup”) firefighter will be positioned immediately behind the nozzle firefighter to help resist the nozzle-reaction burden and provide any other necessary physical and emotional support. The latter can be an important concern when an inexperienced firefighter is assigned the nozzle position for the first time. In reality, however, due to insufficient staffing, the backup firefighter is usually forced to move between a position near the nozzle firefighter and a point several feet behind. This is necessary in order to keep the line free and moving. Due to this situation, the need to use hose-and-nozzle systems that reduce the nozzle-reaction burden without compromising flow volume and stream reach is critical and will be the topic of a future installment.

In the event a third firefighter is available, he should be positioned at the first bend or turn behind the nozzle team as the line is advanced. Staying at this position and resisting the temptation to become the "second assistant nozzleman" requires a high degree of discipline.

To ensure a smooth advance without the danger of "pushing" the nozzle firefighter forward, the "bow" technique is very effective. The third firefighter (called the "door" firefighter in FDNY) simply forms a bow in the line — either on the floor ahead, against the wall in a narrow hallway or even across a bent knee — and observes the hose. When smoke or obstructions such as walls obscure the nozzle team, a straightening of the bow indicates the line is moving. The door firefighter then feeds enough additional hose forward to restore the bow. Eventually the door firefighter must also move forward to keep up with the advancing nozzle team. In order to keep the line moving without unnecessary effort, he may elect to pull a loop of hose forward with him instead of having to go back for more line when it inevitably becomes stuck.

Although specific nozzle techniques will be covered next time, a few points bear mentioning here. One frequently asked question concerns when to open the nozzle. Generally, the nozzle should not be opened until the fire is encountered. An exception might be a situation in which the nozzle team encounters dense smoke and extremely high heat conditions. In this case, opening the nozzle briefly and sweeping the ceiling with a straight or solid stream may be the only means of preventing flashover and severe burn injuries.

If access to the fire area is difficult and fire is encountered at the entrance portal, the following techniques may prove helpful:

- The stream may be directed over the top of a partially open door. Vigorous nozzle manipulation will cause the stream to splatter off the ceiling and upper walls. Hopefully this will "darken down" the fire sufficiently to allow the door to be more fully opened and the advance continued. The stream may sometimes need to be directed through the top of a door which has partially burned away or through an open transom.

- Another effective technique is to drive the water through the space between the open door and jamb. Moving the nozzle up and down several times with the tip inserted in this gap may permit water application into this hard-to-reach area.

- Don't overlook breaching a wall in order to apply water on an otherwise inaccessible fire.

- If multiple rooms are involved on either side of a long hallway, they must be “knocked down” one at a time. Generally, applying water “out front and overhead” will drive back the rolling flame front at the hallway ceiling and permit water to be directed into each side room as the advance is made. Many times the stream can be applied from the door opening, making physical entrance into each room unnecessary. Be sure to control the fire in each room sufficiently to prevent its re-ignition after the line moves forward. As soon as each room “blacks out,” sweep the hallway ceiling again. If a closed door is encountered, be certain to open it and check for fire extension before moving past.

More next time.

Fire Nuggets

February/March 2000

ADVANCING THE FIRST HANDLINE: PART 3

BY ANDREW A. FREDERICKS

This installment will discuss proper nozzle technique (also called “nozzle mechanics”) and burn-injury prevention during fire attack. The two most frequent mistakes I observe when training firefighters in proper nozzle mechanics are these: 1.) Failure to open the nozzle fully for maximum flow and stream reach and 2.) Being too timid when manipulating the nozzle. Previous installments have discussed why only straight or solid streams should be used for interior attack. It is vital that these streams have adequate volume, reach, and penetrating power in order to achieve rapid fire control and keep the nozzle team safe. While straight and solid streams provide many benefits for the fire attack team, the compactness of these streams requires vigorous nozzle movement in order to distribute the water efficiently over the heated fuel materials.

The first mistake, partially closing the nozzle shut off (often done in order to manage excessive nozzle reaction) will produce several negative consequences depending upon the specific type of nozzle involved. In the case of solid-stream nozzles, partially closing the shut-off not only reduces flow volume; the intrusion of the ball valve into the waterway creates significant turbulence that has a negative effect on both the reach and quality of the stream. With a combination (fog) nozzle, both flow volume and effective reach will be compromised. Automatic fog nozzles can be rather deceiving. While stream characteristics (reach, compactness) are maintained and the stream may “look good,” the consequent reduction in flow volume will lessen fire-control effectiveness.

Being overly timid when manipulating the nozzle is another common mistake. Fires are controlled quickly when an adequate volume of water is efficiently applied on the heated fuel materials. If the nozzle firefighter fails to move the nozzle in a vigorous, almost violent fashion, fire control is delayed and the risk of burn injury is increased. It seems there are two main causes for this problem. One is simply a lack of experience and/or poor training. The other is the widespread use of pistol grips. Pistol grips, particularly when installed on 100-psi fog nozzles with their high reaction forces, tend to end up alongside the nozzle firefighter's body. The arm holding the pistol grip is bent at a 90-degree angle and nozzle movement is severely restricted.

While rapid nozzle movement is important, the pattern of these movements must also be discussed. Most of us have heard at one time or another that the nozzle should be rotated with a clockwise motion. If the nozzle were to be rotated counterclockwise, heat, smoke, and flame would be drawn to the nozzle and increase the threat of burn injury. Although this phenomenon has been demonstrated repeatedly and is a proven scientific fact, it applies to fog streams, not straight or solid streams. (It should be noted that the reason for this phenomenon has been debated for many years and explanations have ranged from the effects of charged ions in the atmosphere to the Coriolis force caused by the rotation of the earth.)

In my own experience, the exact pattern of movements will depend on both the size and shape of the fire area and how close I can get to the fire before opening the nozzle. While I generally use a clockwise rotation, side-to-side movements and even up-and-down movements may also be incorporated into the mix. If one combination of movements isn't having much effect, try another. If this still proves less than satisfactory, you may need to seek another vantage point for stream application.

The nozzle should initially be pointed toward the ceiling of the fire area in order to agitate the fire gas layers and break up the stream. This creates coarse droplets that will rain down on the heated contents, efficiently knocking down the fire by eliminating the release of fuel vapors into the atmosphere. Be careful not to let the stream contact the heated ceiling and walls in your immediate vicinity, as this will cause scalding water to splatter about, increasing the burn-injury potential. As the fire “darkens down,” the nozzle angle should be reduced and the stream aimed into the lower portion of the fire area.

Once the fire is controlled sufficiently to permit the forward advance of the line, the floor must be swept with the stream. Sweeping the floor accomplishes several important safety objectives. It pushes aside sharp objects from the nozzle team's path. These may include nails, screws, glass, and hypodermic needles. It extinguishes burning carpeting and cools molten floor tiles and plastics. Sweeping with the stream also “sounds” the floor. A change in the sound of the stream will indicate the presence of an opening ahead. This opening may be the entrance to the cellar stairs, an unprotected shaft, or even a hole in the floor caused by fire burning through from below.

A new burn prevention poster sponsored jointly by the New York City Fire Department (FDNY) Safety Command and the New York Firefighters Burn Center Foundation encourages the nozzle team to “sweep-switch-squat-shift” when advancing the line.* Sweeping with the stream dilutes and cools the runoff water cascading down the walls and collecting on the floor. This runoff water will be scalding hot — as high as 150 degrees Fahrenheit. Water this hot will cause a third-degree burn after only one second of contact with human skin. Even bunker pants will not protect against scald burns.

Switching knees will reduce the contact time between the heated floor and your anterior shin and knee. Consider that when you kneel, your bunker pants are stretched tight over the knee joint, eliminating the air space between the protective layers and increasing the risk of conductive heat burns. Squatting or “duck” walking is also effective, but it is rather difficult for the average firefighter to maintain this posture for an extended period.

Until next time, stay safe.

Fire Nuggets

April/May 2001

ADVANCING THE FIRST HANDLINE: PART 4

BY ANDREW A. FREDERICKS

After a fire has been knocked down, the nozzle should be closed to allow the swirling steam and smoke to "lift." In order to improve visibility still further and to reduce the heat and humidity in the fire area, a window should be located and a fog stream or broken solid stream directed through the opening. If done correctly, the negative pressure created by the stream will produce a noticeable draft into and through the fire area, effectively clearing the atmosphere of lingering combustion products. Any remaining pockets of fire will be revealed and smoldering materials will "light up" for final extinguishment.

If a combination nozzle is used, simply change from a straight stream to a fog pattern. If a solid stream nozzle is used, simply close the shutoff part way to break up the stream and effect ventilation. Removing the nozzle tip will further increase efficiency. It is best to remain several feet back from the window and to stay low in order not to impede air movement. The pattern should be adjusted until the stream fills most of the window area.

At this point, truck company personnel should enter the fire area and begin "opening up" in order to expose any hidden fire extension and to ensure complete extinguishment. During overhaul, it is usually best to remove the handline from the fire area to prevent it from being buried by sheetrock or lathe and plaster. This will also allow the secondary search to be conducted with increased efficiency.

It is tempting to open the nozzle as soon as a hole is made in a wall or the ceiling and fire is seen, but all this will do is create unwanted steam and eliminate almost all visibility. Particularly in the case of ceilings, it is best to wait until the entire ceiling has been "pulled" before operating the nozzle. An important consideration during this phase of the firefighting operation is the need to replace the initial nozzle team with fresh troops. The physical effort exerted during firefighting activities coupled with the physiological performance limitations imposed by bunker gear will rapidly fatigue these firefighters. When personnel resources are less than what they should be (as is almost always the case), the onset of fatigue will be even more rapid and the need to relieve the first due engine company becomes critical in order to avoid injuries.

The so-called "one-cylinder rule" should apply whenever possible. During overhaul, the nozzle pressure can be reduced in order to avoid unnecessary injuries to personnel and damage to property. Water point should be directed into any area of the structure or contents where the potential for a rekindle is likely. If there is any doubt, have the truck company personnel open up further or turn the pile of debris one more time.

Foamed plastic seat cushions and mattresses must be thoroughly soaked (even submerging chair cushions in the bathtub is an option to be considered) or removed to the outside for further extinguishment. NEVER enter a stairway or elevator car with a partially extinguished foamed cushion or mattress. The draft created by moving the cushion or mattress may cause the foamed insulation to burst into flame, trapping you with no escape. It is best to thoroughly soak it first, or toss it out the window to a clear area on the ground below.

In order to efficiently overhaul the exposed studs and joists in the fire room, it is best to first overhaul the contents remaining on the floor before bringing the handline back inside the room. This reduces the chances of the line sitting in smoldering debris, which could unknowingly damage the hose. Utilizing only a single firefighter (remember, the nozzle pressure has been reduced and no one really wants to get wet, particularly in winter), position at a far corner of the room with the nozzle pointed back towards the entrance. While leaning against the wall and using your leg and foot to anchor the handline and resist the nozzle reaction, sweep the stream back and forth along each joist from sidewall to sidewall. Concentrate on the joists that are the most deeply charred and don't hesitate to agitate the stream by shaking the nozzle. Once the joist bays have been washed down, perform the same operation on any studs that look charred (pay close attention to the framing around window openings) and direct the stream from ceiling to floor and back again. Let the officer take a peek, and, if all looks good, reposition the line at the door opening and repeat the process. This will ensure that both sides of each charred joist have been washed down, as well as all affected wall studs and window framing materials.

Don't forget to drive the stream into any area where a pipe (steam, soil, or water), electrical wires, or ductwork pierces the floor above. At this point let the officer make another examination to ensure a satisfactory job has been done. This is actually a good time to bring a thermal imaging device into the room and scan the area for hot spots.

Consider, as well, the following additional points:

- Unlike fire attack operations, water application during overhaul should be very specific. Use water judiciously to avoid unnecessary property damage. Move undamaged valuables if possible.

- Reckless overhauling can destroy evidence of arson. Use care and limit water application to only what is absolutely necessary until the officer or fire investigator takes a look at the area.

- It is easy to confuse steam and smoke. If it is smoke, additional water application is necessary.

- Be cautious of holes in the floor, water accumulations, protruding nails and screws, untrimmed window glass, and other sharp objects.

- Ensure the area is properly illuminated to help avoid injuries.

Until next time, stay low and stay safe!

Fire Nuggets

June/July 2001

WHY FIRES ARE MORE DANGEROUS TODAY

BY ANDREW A. FREDERICKS

For several years now we have been told that fires are more dangerous — hotter, less predictable — than they were 50 or even 25 years ago. The primary reason given for this is the ever-expanding use of plastics in our homes and businesses. Others have countered that this is simply not true, because it is the available oxygen that regulates the heat produced by any compartment (room) fire. For each cubic foot of oxygen "consumed" in the combustion process — regardless of the fuel involved — a fairly uniform 535 BTU's of heat is produced. Since all interior fires are oxygen- or ventilation-regulated, in theory, the heat produced by burning a one-pound block of polystyrene will be almost exactly the same as the heat produced by burning a one-pound block of oak. The problem with this explanation, however, and one of the reasons why fires are more dangerous today, is that it ignores differences in the heat release rates of plastics and "traditional" or cellulosic fuels. Plastics, in general, have much higher heat release rates.

Early in the development of a compartment fire, it is not the oxygen available for consumption that controls the burning rate, but the characteristics of the fuel itself. If the materials burning have higher rates of heat release, we can expect a more rapid build up of heat within the fire area and a reduced time frame until a flashover or other "rapid fire development" event occurs. As Tom Brennan points out: fires may be fewer today (compared to the peak fire activity years of the 1970s), but the incidence of flashover is greater. The dangers posed to firefighters operating in this volatile environment are very real. But an increasing number of flashovers is only part of the story. Smoke conditions have worsened as well. The dark, choking smoke characteristic of fires involving petrochemicals has become a signature of the modern structure fire as petrochemical derivatives (plastics) now represent the single greatest portion of residential and commercial fire loads. One of the dangers posed by volumes of dense smoke is the ease with which a firefighter or team of firefighters can become disoriented and lost. Incidences of firefighters becoming lost in the smoke and subsequently dying from asphyxiation or from burns caused by rapid fire spread have become tragically common. In some cases, the firefighters had a charged handline with them when they entered the burning structure, but somehow became separated from the line and subsequently died. In other cases, firefighters have been severely burned while clinging to the handline, and the reason for this phenomenon requires a closer look at smoke and its makeup.

Smoke is made up of solid particulates and aerosols carried along by convected air and carbon monoxide gas. When you ask firefighters about carbon monoxide (CO) and its attendant hazards, most will reply by rote that it's colorless, odorless, and tasteless. While these characteristics are important, there are three others that cause death and injury to operating firefighters: CO is highly flammable; it has a wide explosive range (12.5% to 74%); it ignites at about 1,128 degrees Fahrenheit (a temperature quickly attained in many room fires). Although the lower explosive limit (LEL) of CO is high when compared to other flammable gases, once the LEL is achieved, CO remains within its flammable limits over a wide range of fireground conditions. When pockets of CO ignite, firefighters performing searches and even those advancing handlines are often burned. Insulated by modern bunker gear and protective hoods from the heat radiating downward from the smoke above them and blinded to rollover by the dark smoke that surrounds them, the critical warning signs of impending flashover go unnoticed. Even “state of the art” turnout clothing cannot protect against burns caused by flashover. Remember too that a charged handline can't offer protection if it isn’t in operation. Perhaps opening the nozzle on smoke, despite what we have been taught, is something we should consider in some cases. If we can reduce the volatility of the smoke, we can prevent burn injuries. Fires involving commercial occupancies, cellars, and confined spaces should be considered prime candidates for applying “water on smoke.”

Still another issue involves the types of buildings and structures we fight fires in today. Void spaces are commonplace in new construction. Voids have also become a problem in buildings that are renovated using “lightweight” components and assemblies. Voids create ideal places for CO to collect and build-up dangerous temperatures and pressures that often result in collapse, smoke explosions or other rapid fire progress events. Buildings are also more insulated today and smoke and heat seepage to the outside is often eliminated. Without benefit of a fire that has “self-vented” prior to the arrival of the first due fire companies, firefighters are frequently subjected to extreme punishment while performing primary search duties and advancing the initial attack handline.

So it is true — fires are more dangerous today. Unfortunately, both human evolution and fireground tactics haven’t kept pace with changes in the modern fireground environment and advances in modern turnout gear. Firefighters still get burned at the same temperatures today as generation ago. Although modern protective clothing has reduced the incidence of many types of burns, when firefighters do get burned, the severity is often very high. Aggressive interior fire attack is the hallmark of a good fire department, yet in an increasing number of instances, it is incompatible with the volatile, well- insulated, lightweight fireground of today. What then, is the answer? It is not one answer, but several. Here are five to start with:

• First, let's restore firefighting to its proper place at the head of the fire department table. Service diversity has in many cases created mediocrity on the fireground.
• Second, lets utilize our protective equipment wisely and gain a better understanding of its limitations — physical, physiological, and psychological.
• Third, lets train more realistically. Use acquired structures whenever possible and forget the propane simulators and “theater” smoke.

• Fourth, make sure we know how much water we're flowing on our fires. The only way to do this is to measure it and make sure we are achieving minimum flows and reach with manageable nozzle reaction burdens.
• Fifth, increase staffing. As retired FDNY Deputy Chief Vincent Dunn has pointed out, we often have most of our too-few personnel on the fireground assigned to every task imaginable except stretching and operating the life-saving first handline. Amen for NFPA 1710. The road just ahead may be a little rocky, but the long-term benefits will be tremendous.

Fire Nuggets

August-November 2001

FATHERS DAY

BY THE LATE ANDREW A. FREDERICKS

On Sunday, June 17, 2001, a fire occurred in a hardware store in the Astoria section of the Borough of Queens, New York. The FDNY was notified and responded with a full first-alarm assignment, including Rescue Co. 4, which was returning from a box in Manhattan. As the first alarm companies went about their assigned tasks, an explosion took place that caused a massive collapse and severe injuries to scores of firefighters. Three firefighters were trapped two beneath tons of bricks that had once been the exposure two side wall of the fire building and a third who was blown down the interior stairs leading to the cellar. After the explosion, the fire rapidly escalated from a second to a fifth alarm; and eventually some 350 firefighters converged on the scene, including all five rescue companies and seven squad companies. This account represents my recollections of the event, as well as the feelings and emotions I experienced during the operations to locate the trapped firefighters. It is not in any way meant as a critique of the incident or even necessarily represents an accurate description of the events as they unfolded. I have found that by talking about the incident, I can better cope with what happened. Since writing is a passion of mine, I thought that by writing about it and sharing those thoughts with other firefighters, the grief might become somewhat easier to bear.

The investigation into the cause of the fire and explosion is ongoing and new facts come to light each day. A recent theory is that a combination of smoke and flammable vapors gases escaping from failed containers of paint, lacquer, and propane stored in the cellar triggered what might be described as a super backdraft a backdraft explosion with enough power to lift a two story, 30 foot by 60 foot building of ordinary construction off the ground and blow out a side wall causing the collapse of the second floor and roof.

I wasn't scheduled to work until Fathers Day night, but because I had to drive some 235 miles to the New York State Fire Academy early the next morning, I switched my night tour with a firefighter who wanted the day off. The morning was bleak and rainy, but sunshine was predicted for later in the day.

We had a covering lieutenant working in place of our regular officer. Like me, he was a native New Yorker who had been a firefighter in Alexandria, Virginia, before being appointed to the FDNY. Our chauffeur was a twenty-year veteran who worked in 43 Truck in Spanish Harlem before coming to Squad 18. The can man was out of one hundred and eight truck in Williamsburg, Brooklyn, and the forcible entry or irons man was from 12 Truck in the Chelsea section of Manhattan. I was assigned the hook and a detailed firefighter from Engine Company 325 in Queens was given the roof position. The nine hour day tour started out no differently than most- committee work, extra effort was given to the stove and refrigerator since it was Sunday, some ball breaking, and a discussion over what to prepare for lunch.

Kitchen duties were soon interrupted by an alarm, which turned out to be false, followed shortly thereafter by a report of smoke that turned out to be steam. While returning to quarters from the steam leak, we were directed to respond to a store fire on 16th Street near Fifth Avenue. We operated at the small all hands fire for about 40 minutes, assisting with forcible entry and performing searches of the store, cellar, and sub-cellar. After being ordered by the chief to take up, we left the scene and had traveled no more than a couple of blocks before we came across a woman lying on the sidewalk. We administered first aid and shielded her from the now heavy rain using two borrowed umbrellas. Once she was stabilized, we moved her into the vestibule of a nearby apartment building and awaited EMS. An ambulance soon arrived, and we went back in service.

Since the morning was so hectic, we decided to pick up sandwiches for lunch. The Mets and Yankees were playing later at Shea, and everyone was hoping the rain would soon stop. We finished lunch around 2:00 and settled in to relax a little bit. The quiet didn't last very long. At about 14:50 hours the voice alarm sprang to life and the dispatcher announced a second alarm in Queens for a fire in a two story taxpayer. A second alarm is hardly unusual, but within minutes this second alarm escalated to a fifth. We switched our kitchen scanner to the Queens fire frequency and the urgency in the voices of the chiefs aides indicated something unusual something tragic had happened. With little time to consider the possibilities, the teleprinter in the housewatch spit out our response ticket to box 55 7512 12 22 Astoria Boulevard between 12 Street and 28 Avenue. It was 15:26 hours, and Squad 18 was on its way to Queens.

Due to our chauffeurs knowledge of the area and relatively light traffic, we made it from lower Manhattan to Astoria in eleven minutes. We parked a block away, collected our firefighting hand tools, and walked up the street toward the fire building. The sight that greeted us could only be described as surreal. Firefighters from Squad 288 and several other companies were sprawled out on the sidewalk with EMS personnel frantically trying to keep up with triage. The exposure two side of the fire building was ahead of us the wall blown out into the street with the second floor and roof hanging down in a supported lean-to fashion. Debris littered the street, and smoke poured from every opening in the collapsed building.

I walked up to the command post, and the first person I recognized was a captain who is currently the fire commissioners executive officer. I asked him, Ray, whats going on. Do we have members missing. He nodded yes. I left the command post and walked around the front of Ladder Company 116s apparatus, which was parked on the exposure two side of the fire building. I couldn't raise my officer by radio, and in the sea of smoke and firefighters, I recognized no one from Squad 18. I noticed many of the firefighters digging through the collapsed brick wall that lay on the sidewalk, so I threw my forcible entry tools into a freezer box lying at the curb and started moving bricks. Seemingly not more than a minute or two had gone by and a firefighter only a few feet from me shouted: I got one! About two dozen firefighters and officers, myself included, began frantically grasping at bricks and debris. The SCBA on my back was a hindrance and made it difficult to balance on the rubble pile. I was finally able to hand it to the lieutenant working in Hazardous Materials Co. 1, with whom I worked in Squad 18 before he was promoted. They had just concluded an operation nearby and when the alarm for the hardware store came in, they responded and assisted with forcible entry.

Paint cans kept exploding and two members of Squad 18 grabbed a 2 ½-inch line to drive the fire away from our position. The work was physical and frustrating, and I remember thinking how bad the smoke was, and I wished I could quit digging. I pushed the notion of quitting into my subconscious and kept working. Several minutes went by, and the first firefighter was pulled from the rubble. Dust was caked in his bloodied hair, and I couldn't make out his face.

The second firefighter was discovered next to the first. I recall the veteran lieutenant from Rescue 2 yelling at me, Andy, you're on his legs! A firefighter from Rescue 2 was standing on debris above the trapped firefighters head. We moved and continued to claw at the rubble. It was difficult finding a place to toss the bricks without interfering with some other part of the rescue effort. Tempers grew short. In addition to bricks, the contents of the store were scattered all over. I remember fighting with mop handles and perforated particleboard partitions used to display hardware sundries. A reciprocating saw was brought in to cut away some wood entangling the trapped firefighter's feet. With Herculean effort, the second firefighter was pulled free and dragged onto a backboard. I helped move him onto a stretcher. He was quickly wheeled away by other firefighters and EMS personnel. I soon found out that one of the firefighters was Harry Ford, the senior man in Rescue 4. I learned later that the other firefighter was John Downing from Ladder 163, who was working his last tour before leaving on vacation with his wife and kids to visit relatives in Ireland.

With the two firefighters removed, we were ordered to enter the cellar of exposure 4 A and assist as needed. I immediately relieved a firefighter operating a pavement breaker being used to breach the cellar wall. I used the tool for only a short time before we were told to reposition and start another breach closer to the front of the building. I set up the tool and began to operate, but after only a minute or two trying to penetrate the brick and stone wall, I physically died. Holding the tool horizontally, even with help the help of my officer and roof man, was like trying to lift up the back end of car. I just couldn't do it. A suggestion was made to try and secure the tool with nylon webbing slung over a joist supporting the first floor. My lieutenant told me to go up to the first floor and size up this possibility. I was relieved, I had never felt so exhausted and this assignment gave me a chance to catch my breath.

Once inside the first-floor apartment, I helped move some furniture so Ladder 115 roof man could cut the floor and expose the joists. After this assignment was completed, I desperately needed some water, so I headed outside and met the forcible-entry firefighter from Squad 18 who was just as tired as I was. At some point I learned that the firefighter trapped in the cellar was Brian Fahey from Rescue 4. I had gotten to know

Brian over the past three years, and I was stunned. We soon joined the other members of Squad 18 in a storefront church on the first floor of exposure 4B to rest and regroup. The can man let me use his cell phone so I could call my wife. I noticed the sun was shining; it had become a beautiful day.

After this short break, we went back to work. Members of Squad 1 had courageously entered the store cellar through one of the breached openings, but were ordered to withdraw due to heavy fire conditions and three feet of accumulated water. We assisted in breaching the sidewalk in front of the fire building in an effort to reach the cellar. The can man, irons man, and chauffeur relieved members of Rescue 5, who were using pavement breakers. The roof man and I helped pass chunks of concrete out from the work area in bucket brigade fashion.

Simultaneously, attempts were being made to reach the interior stairs to the cellar. At one point, Squad 252 used a 2 ½-inch handline to push the fire back within the heavily damaged store while Rescue 3 entered the cellar. While this was going on, the can firefighter suggested we search what was left of an aisle filled with plumbing supplies in the off chance Brian was still on the first floor. The roof man and I joined him, and while moving shelving and digging through debris, a member of Rescue 3 reported he had located Brian in the cellar. It was approximately 18:00 hours. At about 18:30 hours, his body was removed from the fire building by the off duty members of Rescue 4 who had assembled at the scene. Except for the firefighters carrying Brian, everyone removed their helmets as a mark of respect. I had often studied photographs of the 23rd Street collapse, which took the lives of twelve firefighters and officers five from Engine Company 18 now Squad 18 in 1966 but never imagined that I would someday be part of such a grim scene.

By this point, I had no more emotions left. Emptiness is the only way to describe the way I felt. The night tour arrived to relieve us, and they set about the task of finding several tools we had lost during the operation. I finally made it home to eat leftovers at about 10 p.m. I kissed my kids and hugged them and watched the news and cried. I think every New York City firefighter calls home more often now and hugs his kids a little tighter when he gets home safely from work.

Thankfully, the most seriously injured members Lt. Joe Vosilla from Ladder 116 and Lt. Brendan Manning from Ladder 163 are doing better. Many other members remain on medical leave, and some have additional surgeries and extensive rehabilitation ahead. In a touch of cruel irony, the firefighter detailed to Squad 18 for the day was assigned to the same firehouse as John Downing and helped free him from the rubble. I recently saw a tape of the ABC News Nightline segment that dealt with the fire. Despite being at the scene and watching news footage in the days following the explosion, I was astonished at the devastation. That more members weren't killed can be attributed only to the grace of God. The two kids who admitted they spilled the gasoline that ran into the cellar and was ignited by a pilot light starting the original fire were not charged.

I know Ive left out numerous details, but many of these are not important. Since the incident, Ive often felt a sense of failure that accompanies the sadness. I know its quite normal to have doubts in a situation such as this, but that knowledge doesn't seem to make the doubting and second guessing any easier to deal with. In closing, I ask that you pray for the widows and especially the eight children left behind. To Brian, Harry, and John Rest In Peace Brothers.

Fire Nuggets

A TRIBUTE TO ANDY

IN MEMORIAM • SEPTEMBER 11, 2001

As we continue to reflect on the great national tragedy of 9-11-01, let us rededicate ourselves to keeping alive the tradition of courage, compassion, values and love for mankind that is the hallmark of the fire service and so well demonstrated by our brothers who made the supreme sacrifice at the World Trade Center. They set a standard of professionalism, dedication and devotion that should serve as a constant reminder to give 100 percent every day we come to work.

Our thoughts and prayers are with all the friends and families of firefighters left behind. As many of you know, Fire Nuggets' author, Lt. Andrew A. Fredericks, was murdered on 9-11. Andy was not only a gifted writer, he was our personal friend. There is not a day that goes by that we do not think of Andy. Our hearts ache for his wife Michelle, son Andrew Jr., daughter Hayley and all of Andy's family. Since Andy was part of our family too, and so proud to be a huge fan of Fire Nuggets, we have decided to dedicate the entire website to Lt. Andrew A. Fredericks.

This page will grow with personal messages, photos and dedication articles for Andy. Thank you in advance for continuing to support this website not just for the memory of Andy, but more importantly, all of our fallen firefighters, past and unfortunately, the future fallen heroes as well.

Fire Nuggets

A TRIBUTE TO LT.ANDREW FREDERICKS

OUR BROTHER ANDREW FREDERICKS, SQUAD 18, FDNY

BY JAY COMELLA AND TED CORPORANDY

On September 11, 2001, the fire service lost hundreds of brothers. Among the ranks were some of the most talented firefighters and greatest leaders our profession has ever produced. Fireman Andy Fredericks was one such man. He was inspirational, dedicated and brilliant. The consummate engineman, his utmost passion was for the basic tools of our trade, hose and nozzle. His greatest concern was the most efficient use of these fundamental weapons of fire fighting. At the heart of his message was the superiority of the smoothbore nozzle over the fog nozzle. His research and study and subsequently his teaching and writing on this most basic fireground element, the nucleus around which all other operations revolve, was incredibly detailed and intricate.

Andy left us with a wealth of knowledge but it would be naïve to think any one member of the fire service could fill the void created by his loss. He touched many of us across the country through his articles, hands-on training, lectures, and videos. He created many disciples of his no-nonsense, back-to-basics approach to combating today's ever more complicated and dangerous fire problems. Those fortunate firefighters who benefited from his instruction must carry on his work with renewed commitment. President Lincoln said in the Gettysburg Address, "…It is for us, the living, rather to be dedicated here to the unfinished work which, they have, thus far, so nobly carried on." These words are fitting. Only collectively we can have the same positive effect on the fire service that Andy had as an individual.

Andy's passion for his work as an author, educator, instructor, and trainer resulted in improvements in fireground operational efficiency and safety. These improvements have no doubt saved the lives of civilians as well as firefighters. This is his legacy to all of us. For those of us in the fire service he is a shining example of dedication, character, professionalism and love for mankind.

We have shed many tears over the loss of our brother, friend and mentor; but this is tempered by the memory of his unrelenting humor and his quick and sarcastic wit. He always kept us on our toes, and he always had us laughing. Over the years, tears may diminish; but our memory will never fade.

To our brothers in FDNY and Squad 18: the entire fire service shares the burden of your grief. And to Andy's family to whom he was so devoted and loved so much, his wife Michelle and children Andrew and Hayley, our thoughts and prayers will always be with you.

God bless you, Andy. Life is not the same without you.

Fireman Jay Comella
Oakland Fire Department

Battalion Chief Ted Corporandy
San Francisco Fire Department Co-publisher, Fire Nuggets

Reprinted from Fallen Heroes A Tribute From Fire Engineering.

READER TRIBUTES TO ANDY

Like many brothers across the country, I have learned a great deal by the message and movement the late Andrew Fredericks created. We will never be able to recognize the number of injuries and lives saved by Andy's teachings. The fire service has been forever changed by one man's dedication and commitment to firefighter safety and quality engine operations. We have used Andy's message extensively in developing classes and training for our engine companies. We have also had the opportunity to spread the word through a Firefighter Safety Symposium put on annually in Boise. This conference usually draws firefighters from around the northwestern states and has proven to be a great training opportunity for many smaller departments.

While credit certainly will always be given to Andy for his work, this is an attempt to let some brothers know how important they are to the people who never had the opportunity to know Andy. After the loss of a friend or loved one, it seems we often find ourselves regretting not having recognized them for their importance in our lives. There are brothers amongst us right now that are carrying on as Andy's ambassadors and are continuing to shape the fire service. To these individuals we will also always be indebted.

Dave McGrail, Denver Fire; Jay Comella, Oakland Fire; Mark Wesseldine, FDNY; and Jeff Shupe, Cleveland Fire, are just a few of the men that are carrying the torch. These brothers are dedicated to bettering our profession and keeping us safe. They contribute a great deal of time and knowledge to help other firefighters and fire departments. The resources they provide through articles, seminars, classes, and conferences such as FDIC, benefit our profession on a daily basis. If ever given the opportunity to attend one of their classes, don't miss it. If ever given the opportunity to meet these gentlemen, take it. The knowledge you can glean from these brothers will help you improve your operations immensely. We all owe these men gratitude for their dedication.

I will never have the chance to know Andrew Frederick's personally, but I feel as if I still know him through the incredible people who did. I thank these brothers for their commitment to us all. — Fraternally, Rick Payne, Boise Fire Department

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It has now been almost 22 months since September 11, 2001. Andy Fredericks was a good friend, co-author and just a great guy. I personally miss him very much. Andy was a pacesetter in the realm of delivering water to extinguish the fire! What a novel idea. There is just so much more to do and teach in his area of expertise. Rest in peace, my friend. We will NEVER FORGET! — Jim Regan

* * * * *

I never had the privilege of meeting or attending one of Andy Frederick's classes, but he has had a great impact on my career. Andy's articles and videos on the basic fundamentals of firefighting has inspired me to learn more about nozzles and the proper and safest ways to apply water on a fire. Thank you, Andy, for sharing your wealth of knowledge and making me realize how important the littles things are to making our job safer. I have become one of your ambassadors. — Brett Graves

* * * * *

My name is Jason Camper, and I am a firefighter from Parker, Colorado (a suburb of Denver). I had the privilege to attend FDIC West in 2001 and took the Handline Advancing class, with Andy as the lead instructor. I was floored by his dedication and vast knowledge of hoseline work and engine company ops. It was very apparent that he thought of this work as an "art." There's much more to engine work than dragging hose. Since then, I have read as many Fredericks articles as I could find and have helped to implement some change in our interior operations based on his work. This year, I attended FDIC West and took the Handline class and Standpipe Ops class again. I appreciate the work that many of you have done in remembering Andy's relentless dedication to this facet of our job.

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My name is Matt Daly, and I was Andy's personal fire photographer who supplied him with most of his photos. This is a great tribute to Andy. I just needed to write and tell you. Thank You. — Matt Daly, FDNY

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My name is Dave Newman, and I am a firefighter in Southern California as well as an instructor for our local college fire tech program. While teaching fire attack a year ago, I showed two of Lt. Fredericks "Bread and Butter" videos, and have been intrigued by him ever since. I plan on showing the videos to the next academy class, as well as providing handouts that explain the man behind the videos. I want the individuals entering the fire service to understand the dedication that Lt. Fredericks gave to the fire service as a whole, and what a true hero he was. Not just at the WTC, but throughout his career. His work will definitely never be forgotten. Thank you.

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I just want to say that this is a great website. I have been trying to find information on fallen brother Andrew Fredericks. I personally never knew him. But I wear a memory bracelet with his name on it. I have found some information on the Squad 18 website, but this has great stuff. Thanks. — Ryan Kaliher

The Journal News

Article by Bob Baird

It's a scene we've all watched on television news — one you never think will be played out on one of your streets, in your community. Unfortunately, over the past month, it has been repeated all too often in all too many communities, some right here where we live. And today, outside Sacred Heart Church in Suffern, we'll see it once again. And once again, it will hit too close to home. Firefighters from every Rockland department and from most departments in Bergen and Orange counties will line Washington Avenue to honor Andrew Fredericks of Suffern, a New York City firefighter who died in the Twin Towers attacks. Side by side with them will be firefighters from Rochester, Syracuse and other upstate departments. They will stand shoulder to shoulder with firefighters who have come from Ohio, Michigan and possibly as far away as Florida. They've come to honor Fredericks, but they've also come to give thanks. Fredericks, who was attached to the NYFD's Squad 18, was an author and teacher, a national authority on engine company operations. He started out fighting fires as a volunteer in Suffern, and before long realized he wanted to make it his career. He and Joel Kanasky, another Suffern volunteer, took jobs in Alexandria, Va., just to get a start. Later, they returned to Rockland to become members of New York City's bravest and to teach at the Rockland County Fire Training Center in Pomona. FDNY Lt. Mike Wilbur of Otisville worked with Fredericks for about five years, starting in 1990 at a firehouse on Webster Avenue in the Bronx. He fought fires next to Fredericks and taught with him at the New York State Fire Academy in Montour Falls. It was there, Wilbur told me last night at Fredericks' wake at Scarr Funeral Home, that his friend taught firefighters from Elmira, Rome, Utica and all across New York. "He had a tremendous sense of humor," Wilbur said, but what impressed him most was Fredericks' dedication. "His thirst for knowledge about our craft was insatiable," he said, "and he had a remarkable ability to teach others. "He was a national expert. He fulfilled his teaching responsibilities while balancing his family life," Wilbur said. Fredericks did some of his teaching at national firefighting conferences. At one of them, about four years ago, he so impressed three fire instructors from Ann Arbor, Mich., that they drove more than nine hours to pay their respects last night. After that conference, they asked him for advice on their rapid response training program based at Michigan State University. "He rode with us at night in Detroit," said firefighter Andrew Box, adding, "He was always talking about his wife, Michelle, and their kids." As much as Fredericks loved the fire service, he loved his family more, Box said. As they wanted him to teach more in Michigan, he was concerned that the travel would keep him from home. He was going to make the trip in December for a state conference, said Training Chief Don Fisher, who praised Fredericks as "one of the best authors of our time in terms of fire service." Fredericks, who wrote often for Fire Engineering magazine and produced training videos, also had his own consulting company and was an adjunct lecturer at John Jay College. His loss is a serious blow to the staff at the Fire Training Center, said Dan Greeley, Rockland's assistant director of fire and emergency services. "There was nobody who knew more about the fire service than Andy," he said. "He lived it." About 1,000 people paid their respects throughout the day and evening yesterday, and many more — including Mayor Rudolph Giuliani — are expected in Suffern for his funeral. Many have come, Wilbur said, because Fredericks had always traveled to teach them. But it's more than that, Greeley said. "The knowledge he provided others has saved many of their lives and the lives of many others." Because of his extensive writing, the films and his teachings, Greeley said, that will continue long into the future.

Fire Engineering
March 2012

ANDY FREDERICKS TRAINING DAYS

BY DAVE COOPER

It is hard to recall when you first heard the name Andy Fredericks, isn't it? It is one of those names which has been synonymous with the fire service in New York City. It ranks among the likes of Dennis Smith, Vinnie Bollon, Ray Downey, John Norman, Paddy Brown, and Mychal Judge. They are names that belong to men whose legacy is woven not only into the fabric of New York, but into the American fire service in its entirety. Their legacies were here before an entire generation of firefighters came on the job and will likely long remain after the coming generations retire.

Like many of my generation, my introduction to Andy Fredericks was posthumously through his writing. The first article I remember reading was Andy's account of the Father's Day Fire that claimed the lives of three firemen in the Astoria section of Queens in 2001. A few short months after Andy's emotional account of that tragic day, he himself would be among the 343 FDNY members who perished in the collapse of the Twin Towers. Since that time, the post-9/11 generation of firefighters across the country have come to know Andy through his technical articles and Fire Engineering "Bread and Butter" series videos.

In 2009, a different kind of training event debuted in the small southern city of Alexandria, Virginia, just outside Washington, D.C. It began as a collaborative effort that spanned from the Potomac to the Hudson, aimed at furthering the technical knowledge that Andy championed while raising funds for the Fredericks family.

Andy Fredericks Training Days (AFTD) – now in its third year and officially hosted by IAFF Local 2141 – saw a near-capacity audience in the iconic George Washington Masonic Memorial this year. Firefighters from across the country came, in a manner of speaking, to pay their respects in the most appropriate way possible to a man that has left an immeasurable mark on the profession of fighting fires; they came to have a few laughs, share a few drinks with other students of the job and, most importantly, to further their knowledge in the basic tasks of structural firefighting.

Alexandria has a unique firefighting history: George Washington is said to have purchased the first fire pumper in this city that lays claim to being the home of the oldest continually operating fire department in the United States. The Alexandria Fire Department (AFD) also protects what is considered to be the most pristine eight blocks of existing Colonial America. Due to the almost immediate occupation by the Union Army during the Civil War, much of Alexandria was spared the destruction that many southern cities met during this period in U.S. history. The fate of the city's original fire companies, tell a different story of occupation. The U.S. Army Quarter Master Department, established the U.S. Steam Fire House right on Princess Street, and promptly went about the systematic destruction of the equipment of almost every other fire company in the city.

Given the distinct history of the AFD, it seems fitting that an equally distinct firefighter like Andy Fredericks would begin his career as a paid firefighter there. He didn't come to Alexandria green, however. By the time he came on the job in Alexandria, Andy had spent several years in upstate New York as a volunteer and an instructor. He had followed childhood friend Joel Kanasky to Alexandria while they both anxiously waited to be appointed to the FDNY. Andy's call came first; Kanasky was not far behind.

Andy soon found a home in the Bronx at Engine 48 with the likes of then Captain John Salka and firefighter John Grasso. Later, Salka would be promoted to Battalion Chief and Grasso to Lieutenant. In the first year of AFTD, Lt. Grasso recalled Andy's early days in the Bronx. Without revealing his several years of experience in the fire service, Andy tasked himself with knowing everything about the rig he was riding and the uses for every tool and appliance. When Grasso explained the purpose of the flow gauge Andy decided everyone needed to understand its use. Shortly thereafter, Andy delivered an article to Fire Engineering on the flow gauge. This would be one of many articles that Andy would write for various fire service publications and websites. These writings would offer a breadth of technical knowledge delivered in an easily understandable fashion. There is no doubt that Andy's time on Engine 48 helped shape his career and, consequently, have a tremendous impact on his department. During his time in the Bronx, Andy, Grasso, Salka, and the men of Engine 48, carried on in the tradition of the tough Bronx engine company. With that brawn brought brain, and the experience gained would subsequently go on to help revise the FDNY's engine company operations.

In 1998, the FDNY established seven squad companies in a move to respond more efficiently to hazardous materials incidents. Among those new companies was Squad 18, housed in Manhattan's West Village, where Andy found a new home. During this period, Andy would write what is probably the definitive technical article on nozzle selection entitled Little Drops of Water: 50 Years Later for Fire Engineering. In this two-part article, he challenged the conventional wisdom that proponents of the fog nozzle had championed for decades. He made sound arguments based on history, science, and his vast personal experience. He dug into the old technical manuals, text books, and industry press, and rooted out the misapplication of a tactic he regarded as one that "confused a generation of firefighters." As Kanasky would say of him at this year's AFTD, "Andy was meticulous. This was a guy that cleaned the baseboards in his house with a Q-tip!" It was this meticulous approach that landed him among a handful of influential voices that began to give growing credence to the use of the smooth bore nozzle. These guys were tired of getting boiled like lobsters during interior attacks, and Andy's work gave them the science and the practical application to avoid it.

It was also during this period that Andy was beginning to become a known personality in the fire service. He was writing articles, appearing in instructional videos, and speaking at FDIC. Given all that, and the demands of his full time job and family life, there is one consistent theme that prevails when guys who knew him or had personal interactions with him speak about Andy Fredericks: That theme is that he had time for everyone, no matter how big or small the department, or how simple or complex the question directed at him. He spent time talking with guys, offering them technical advice, and perhaps most importantly, listening.

After Andy's death on 9/11, it would be Kanasky, now assigned to FDNY's Rescue 1, and Dan McMaster, who also made the trip north from the AFD to the FDNY, that would manage the Andrew Fredericks Family Fund.

McMaster, who returned to Alexandria in 2001 and is currently a Captain with the AFD, explains that: "At the time of Andy's death, the brothers in Alexandria collected a nice amount to benefit the families of those who were lost. A significant piece of that money was given to Joel Kanasky and me to create a fund specifically for Andy's family. At the time, we were too overwhelmed to think things through completely, so the money sat in a college fund for Andy's kids, Andrew and Hayley, for a few years. The fund was always something that both of us were aware of, but didn't discuss or plan for very often."

Reluctant to embark on yet another golf tournament, 10k run, or t-shirt sale to raise funds, it seemed a training event would be the most appropriate way to provide material support for Andy's family, as well as preserve the legacy of a man who gave so much, not only to individual firemen, but to the fire service as a whole.

In 2009, the first AFTD in many ways took on the character of a wake. All of the instructors that year had been personal friends of Andy's, and for many, it was an emotionally raw moment when Captain McMaster took the podium to offer opening remarks. "It was hard," says McMaster, "You're in front of 300 people and you're talking about a guy who is not around anymore."

As a result, in the following year there was a conscious decision on the part of the organizers to lighten the mood and, perhaps, make it a bit easier on those who knew Andy personally. Very few words were spoken about the namesake of the event. Captain McMaster explained that, at the end of the 2010 event, many attendees, those with no personal knowledge of Andy, wanted to know who he was and why so many people were drawn to him.

While the technical instruction of AFTD has been second-to-none since its inception, the harder question remained of how to speak not of Andy the technically sound firefighter, but of Andy the man, husband, father, friend, and neighbor. The 2011 AFTD, however, offered a middle ground that warmly, yet soberly, remembered Andy through the recollections of his peers with stories from both on and off the job. Organizers and instructors alike seemed to hit their stride in honoring Andy's contribution on the job and still remembering him in his personal life. The mood had shifted from somber to celebratory.

In its three years of existence, AFTD has never offered any fire service buzz words. No classes about USAR, vehicle extrication, hazmat, or swift water rescue. It's all meat and potatoes work: forcible entry, ventilation, high rise fires, and, most importantly, engine company operations. The Training Days have always been about the blue collar work that is the backbone of the fire service and the ability to use your head for something other than a place to hang your leather helmet. It has been about remembering those who have come before us and honoring their memory by sharing what they have left behind. Most importantly, it has been about rank-and-file firemen coming together to fellowship, learn, and spend time talking about the greatest job on the planet. Andy Fredericks Training Days can be summed up by Joel Kanasky's opening remarks as he warmly remembered the contributions of his childhood friend: "This job has always been about two guys, one line, one hallway, and a good push."

Fire Nuggets

LIFE AND FAMILY: LEGACIES OF A LOSS

BY MARK WESSELDINE

My name is Mark Wesseldine, I'm a NYC fireman. Ted and Paul have been asking me for years to write a column for Fire Nuggets. I never got around to writing anything. I am a "hands-on" type of person. My friend and colleague was the writer. That's why I'm writing this column. He's gone now!

The night before the "Fathers Day Fire" my girlfriend asked me how many firemen have died since I started? I didn't know the number. I guessed at around 30 or so.

On my way out of headquarters, I looked at the wall of names of the men who died in the line of duty since our departments inception. I then went to the year I was appointed and started counting. When I was finished, I was at 58. I was shocked at that number. By the time I was to get home three more brothers would have to be added to this list. Two whom I knew, one who was just in a class of mine about a week and a half before he died. Times were tough.

Since firefighting began, firefighters have died. Since I began my career, 61 firemen have died in NYC — pre-9-11. Many, many more nationwide. Pre-9-11, on a personal basis, I only knew less than a dozen who gave the ultimate sacrifice. None that I could say was a close friend. Nine-eleven changed that. Nine-eleven is, no doubt, the worst day of any firefighter's life, let alone a NYC firefighter's.

I had to stop; my kids asked me what's wrong? I'm crying as I write. They know why. I've cried everyday since 9-11. I'm not the only one. I'm only one of tens of thousands. On that day, I lost 49 friends, many of them close friends, and many acquaintances.

I guess that's why I'm writing this column. What to do? Where to go? What to say? What to think? I know there are many of you out there thinking the same things. I know — I was just teaching with a bunch of you a few weeks ago. Talked with another a month or so ago late at night. We all feel the same way. Whether you're from NYC or any other department across this great country of ours and you knew someone who's gone, you know how I feel. We can all see it, feel it, and sense it when we're together. We just don't really talk about it.

Recently, while on a work/vacation trip out West, I attended a Little League game with a great friend and his family. His son was playing. He was pitching. Now, I've attended many a kids sporting event or kids play. Many of them with my friend Andy Fredericks. We would watch for hours. Now, whenever I attend any type of event or family function, it really hits home. I think how grateful I am to be able to still be there to attend. I think about those who are watching now from above.

With all the things to do in Northern California, I think my friend Paul was wondering why I wanted to "Just go to a Little League game." He knew why, he's one of us.

That day our little hero pitched eight strikeouts and had five RBI's at bat. And I was grateful just to be there to watch him and his Dad having a great day. By now maybe you've figured out where this column is going; I haven't. Appreciate the times we have together. Tell your kids, your families, your friends you love them. Do the things you've always wanted to do, NOW. Make the most of life. It really is short!

To all my brothers and sisters: I thank you on behalf of the entire FDNY for your support.

ANDY, WE MISS YOU!!!

Mark Wesseldine, FDNY

Fire Nuggets

A DAY OF REFLECTION

BY PAUL SCHULLER AND TED CORPORANDY

Across this great country of ours many firefighters, family and friends, in one way or another, honor those who perished on that tragic day in September 2001. We wish to recognize and thank all who continue to remember our fallen heroes to ensure we “never forget.” This article is about a day when many gathered to honor all 343 fallen firefighters and one in particular who was our personal friend, lead instructor and fellow author, Lt. Andy “Nozzles” Fredericks, Squad 18, FDNY.

On Thursday, October 2, 2003, Firenuggets.com sponsored the Second Annual Lt. Andy Fredericks Memorial Golf Tournament at Greenhorn Creek Golf Course in Angels Camp, Calif. (located in the Sierra Nevada foothills). It was on this day we would all, once again, memorialize our fallen brother, Andy Fredericks. The weather was perfect, the setting breathtaking!

After the 2002 event, we traveled to New York for the Firefighters’ Memorial which was held in Madison Square Garden on October 12, 2002. What a wonderful time to bond with firefighters from all over the world! An additional highlight of our trip was visiting Andy’s final resting place with about twelve of Andy’s friends/H.O.T. instructors. We endured pouring rain, but found peace and comfort being with each other and in listening to some of Andy’s favorite music while raising a beer in his honor. To complete the trip, we also had the pleasure of delivering the proceeds from the 2002 tournament to Andy’s family.

The Fredericks family was very moved by the kind gesture. When we received a thank-you card, we were pleasantly surprised to hear that Andy’s son Andrew wanted to attend the next tournament. So, guess what? Once they heard about the 2003 Tournament, the Fredericks let us know they would all be here! Andrew’s only request was that he be given the opportunity to hit the “first ball.”

As this year’s event was being planned, several firefighters from Denver were among the first to secure a tee-off time. By the time this day arrived, we had doubled the size of last year’s tournament, with thirty-eight golfers and seventy-five attending dinner.

As the 2003 tournament began, a moment of silence was observed. Then, with Mom and sister Hayley nervously watching, Andrew connected with the first ball, driving it 150 yards! Boy, was he smiling; and mom was relieved too!

As we were checking in, the starter said to us, “You all will be starting from the white tee.” No firefighter asked “why” for a change; we just did what we were told and set up at the white tees!

Now, picture this: there are white tees, red tees, blue tees, and yellow tees. And, as you may be aware, each tee location is indicated with a yard marker (distance from tee to hole).

One foursome after another teed off while others waited for their group to be called. All of a sudden, a brother looked down at the white-tee yard marker and almost fainted. The yard marker read 343 — the very number of the fallen firefighters on 9/11! What are the odds of this? The golf management was somewhat clueless to begin with, but quickly understood the significance of what had occurred. After regaining composure, we all realized this was meant to be, and as Michelle Fredericks said, “They are all here with us today.” Needless to say, a few tears were shed and hugs exchanged.

Throughout the evening, various individuals shared memories of Andy; and the Fredericks family was presented with two priceless treasures. The photo of Andy’s Bunker Gear captured during FDIC West in May 2001 (now also displayed at Squad 18’s quarters), and a beautifully framed poem, written and read for this occasion by Captain Mike Veseling of the Naperville, Illinois, Fire Department.

Nearly $4,500 was raised this year. All proceeds will be applied towards the creation of a monument/sculpture of Andy, to be erected at the New York State Fire Academy. Andy was a devoted instructor who truly impacted many at this facility. We are grateful to the academy for their willingness to have a sculpture of Andy placed there for all to honor for many years to come. We know more funds will be needed and, therefore, will continue to raise money until this project is complete.

For those of you who knew Andy, you realize the gift that was bestowed upon you. For those who never had the pleasure of meeting or hearing of Andy’s work, know this: Andy was a nationally recognized and gifted instructor and author who made a tremendous impact in the fire service. As Andy’s dear friend Mark Wesseldine, FDNY (ret.), said, “Andy did not preach New York City, he preached what worked.”

There is no doubt that through his teaching, Andy saved many firefighter and civilian lives and continues to do so. Andy has countless disciples, a number of whom continue to carry his message forward.

Most importantly, Andy was a kind and humorous man, a friend to many, and a devoted husband and father who is deeply missed by all.

God bless you, dear friend. We miss you!

Paul and Ted

Paul Schuller and Ted Corporandy are the founders of Firenuggets.com and firefighters in San Jose, Calif., and San Francisco, Calif., respectively.

ANDY FREDERICKS'S PARTING GIFTS:

A PERSONAL REMEMBRANCE

BY PAUL SCHULLER

This wonderful photo was captured during FDIC-West's Hands On Training (H.O.T.) Program in May 2001. We were all enjoying a break when a young firefighter, who was simply intrigued by Andy's turnouts, arranged his gear for this incredible shot. Obviously, no one realized then how meaningful this picture would become.

Andy left us with another special memory. His last published article, titled "Father's Day," was presented in the August 2001 issue of Fire Nuggets. The content of this article was a total departure from Andy's engine operations theme. I remember him asking, "Hey Paul, do you mind if I do something a little different?" Naturally, he received our blessing. After all, never would we question the master! In this writing, Andy shares his personal and exhausting experience during the Queens Father's Day fire and recovery of three fallen brothers. Andy's message to us is emotionally charged and packed with encouraging words that may help us all deal with the tragedies we face in this most stressful profession.

Most of all, Andy touches on the importance to make time for family and never forget or be afraid to say I love you for you never know what tomorrow will bring. I know Andy loved his family and missed them when he was on the road teaching all of us. I remember us both sharing many stories about our families, and found many similarities between us. After spending time talking about our wives and kids, we would have to pull out the cell phones and call them to say, “Hi,” because we missed them so much. To Michelle, Andrew Jr. and Haley, I pray you will find a little comfort in knowing your husband and dad has impacted so many lives as a firefighter and friend; and let’s not forget all the lives he saved too! Andy along with many others are our true heroes!

I never spent too much time wondering why the picture and “Father’s Day” article came about, but I can tell you this; four months after receiving these gifts from Andy, he was gone. Why we have these memories is much more clear to me today. Andy, I know I will see you again and be honored if you save me a spot on your heavenly squad.

I love and miss you, dear brother.

Paul (Schoo) Schuller
Co-publisher, Fire Nuggets

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Fire Nuggets

AND THERE YOU WERE

BY CAPT. MIKE VESELING, NAPERVILLE (ILL.) FD

So tiny and fragile, my large calloused hands held you so close.
Afraid that I would hurt you, but wanting to hold you in my arms forever.
And as I carried you so easily round playground and park, I gained great strength.
A strength that would enable me to pull cotton and brass up countless stairwells,
to pull lath and plaster, and to carry the innocent to safety through the darkest of nights.
My precious little girl, I needed a great strength, I looked around
and there you were.

How many times my son did we play catch and bat balls?
I wanted to teach you all that I knew…of life
and what it meant to be a man, what it meant to be a Fireman.
Yet through my mentoring and teaching, it was you who taught me.
You inspired me to reach out to my Brothers
to guide and instruct them, to bring out their very best,
so that none would fail, so that none would fall.
I set out to teach, but had so much to learn…
and there you were.

And my Dearest sweet wife.
I wanted to be your Knight in shining armor,
Instead , I found myself stained with soot and ash.
I wanted you to feel safe with me and to never fear,
but it was you who protected me.
You showed me such incredible love, that during battle
you gave brilliance to my darkened armor.
I wanted to keep you … yet it was you I felt with me in so many darkened halls.
When I felt most afraid, I looked around,
and there you were.

My wonderful family,
do you know what you have done?
Do you realize that all that I am, I owe to you.
Do you realize that within you, through you, that I will live forever?
You gave me the strength to save so many timid souls…
You gave me the wisdom to teach a nation of Fireman...
You gave me the heart to press on, to never cower,
even when the shadow of death surrounded my Brothers and I.
They call me a hero, but when I needed a hero of my own…
there you were.

THE LIST** **(As posted on the website <u>MidwestFirefighter.com</u>)

In excitement for the upcoming Andy Fredericks Training Days I had to post “the list” that was last viewed on www.thehousewatch.com on September 29, 2008…
-Nate Jamison

One day, a Fireman from Engine 48 in the Bronx decided to come up with a list of Engine Company basics; to be used as a punch list for training, classes, after-fire critiques at the back step, etc. His name was Andy. Over the years, Andy and his good friend (and ours) John, another great from Engine 48 who went on to become one of the FDNY's best Engine Officers, continued to add to the list. In September 1995, Andy wrote the seminal article, "Return of the Solid Stream" (Fire Engineering) that shook the fire service's very foundation and caused us to actually take a look at the nozzles we were using for years; and more importantly, what they actually did for (to) us. His later works included the two-part epic "Stretching and Advancing Handlines Part I and II (Fire Engineering) and many articles in Fire Nuggets; and Andy solidified himself as the most prolific author and academic on Engine Company operations. More importantly, at a time when everyone was writing and focusing on the Truck, Andy made it cool to be on the Engine again; and brought the mission of the Engine out of academic obscurity to the forefront of our operational focus. Although Andy is no longer with us, his work always will be. I am very fortunate to have the opportunity to spread Andy's message with those he brought together, and I hope you all will continue his work too. We owe it to him and the job.

Recently, John was looking through some old folders the other day and found some overheads of Andy's (their) original list. He mentioned that it would be a great idea to pass it on to you all; and have us all add to the list and or discuss the individual points (basics). Many of you may recognize the points on the list and some of you may not. Regardless, these basics apply as much today as they did when they were written. Please add your thoughts, additions, discussion, etc. in the comments section of this post. Thanks John, for giving us The List.

Engine Company Basics

More lives are saved at fires by a properly positioned hoseline, than by any other life saving techniques available to firefighting.

The fire "goes as the first line goes". All efforts should be concentrated on stretching, charging and operating the first line. Don't be consumed stretching the back-up line until the first line is stretched and operating unless you have the manpower to perform both functions.

Do not become overly reliant on pre-connected lines. You must prepare and train for the fire that can't be reached by a pre-connected line. You must be capable of extending a line that will not reach the objective.

Select the proper size line for the job at hand. "Little fire, little hose". "Big fire, big hose". Don't be afraid of the 2½ line. With the proper nozzle (smooth bore) and proper pump pressure this line can be managed even in understaffed departments.

Do not pull and pile the hose- stretch the line correctly.

Do not enter the fire area with an uncharged line. In private dwellings (1 and 2 story homes) the line should be stretched and flaked out in front of the building, than charged before entering.

Bleed the air from the line prior to advance.

All members should be on the same side of the line.

Back-up must lend physical support to resist nozzle reaction and allow nozzle firefighter to operate freely.

Do not crowd the nozzle.

"Wait until you see fire and don't open up on smoke" does not apply in the fire environment today. Plastics and energy efficient windows have changed the fire environment. If you are wearing your gear properly, full bunkers with hood, you cannot use heat as the indicator to open the nozzle. Once you feel heat through the gear it is too late. The next thing you might see in your facepiece is orange because the room just flashed! If the smoke is dark and angry (swirling around in front of your facepiece) open the line to cool off the ceiling.

Stream should be directed out in front and overhead. Water should be deflected off the ceiling and upper walls. The deflected water will:
- cover a greater area
- cool superheated combustible gases at the ceiling level
- prevent rollover of fire overhead
- prevent the development of flashover

Sweep the floor as you advance to prevent knee burns. NYC has seen an increase in burns from scalding water which enters the leg opening in the pants which forms when you kneel. Once the line is advancing, keep moving toward the seat of the fire, but don't push the nozzleman faster than he wants to go. Let the reach and penetrating power of the stream do the work, especially in large area buildings or when several rooms are involved.

Ensure adequate ventilation to assist with extinguishment

9/11/01 NEVER FORGET!!!!!

"Take the time to make the time."