FIRE AND RESCUE DEPARTMENTS
OF NORTHERN VIRGINIA
FIREFIGHTING AND
EMERGENCY OPERATIONS
MANUAL

ENGINE COMPANY OPERATIONS

Third Edition

Issued: November 2003
Revised: December 2022

ACKNOWLEDGMENTS

The *Engine Company Operations, Third Edition* manual was developed through a cooperative effort of the following Northern Virginia fire departments:

- City of Alexandria
- Arlington County
- City of Fairfax
- Fairfax County
- Fauquier County
- Fort Belvoir
- Fort Myer
- Loudon County
- City of Manassas
- City of Manassas Park
- Marine Corps Base Quantico
- Metropolitan Washington Airports Authority
- Mount Weather Fire and Rescue Department
- Prince William County
- Stafford County

The Northern Virginia Fire Operations Board managed the development of the manual's first and second editions (released in November 2003 and December 2013). The Northern Virginia Fire Operations Board oversaw production of this third edition with content developed by the Technical Writing Group.

PREFACE

The NOVA *Engine Company Operations* manual is designed for use as a resource and reference for all fire department personnel in Northern Virginia assigned to engine companies. This manual is intended to provide firefighting knowledge, skills, and tactics in engine company operations to complement basic skills and increase efficiency.

The purpose of this manual is to:

- provide guidelines and general information regarding engine company operations,
- describe the duties and responsibilities of the engine company,
- identify tactical and strategic considerations for engine company operations,
- define engine company officers and firefighters' roles and responsibilities, and
- establish guidelines for apparatus positioning on the fireground.

The key changes in the third edition of the *Engine Company Operations* manual involve significant content reorganization to improve document structure.

INTRODUCTION

The engine company is charged with identifying and securing a water supply, conducting a thorough size-up, developing initial strategy and tactics, and deploying hoselines for extinguishment. This manual provides both general and specific information relevant to engine company operations by describing the duties and responsibilities of each engine company member.

Response areas vary greatly across the Northern Virginia area, yet the basic duties of the engine company remain the same: establish a water supply and stretch, advance, and operate hoselines in a manner that renders success on the fireground. Engine companies vary in layout as the first due of the engine company dictates apparatus setup. Various engine makes and models exist, and the differences between them include hose bed size and layout, location and number of discharge outlets, location and number of compartments, position of equipment, and supply-line connections.

This manual is based on engine company staffing that consists of one officer and three firefighters. Jurisdictions operating with a crew of less than four will need to adjust member responsibilities as outlined in this manual to complete the necessary engine company fireground tasks. Engine company firefighters must familiarize themselves with the apparatus currently in service. Before arriving on the fireground, personnel should consider how crew members who have been detailed from other engine companies, use of reserve apparatus, and working with mutual aid companies will affect their established operational procedures.

GLOSSARY

The key definitions used in this manual are as follows.

Knox box – A Knox box is a small, wall-mounted safe that holds building keys for retrieval by fire departments, emergency medical services, and police during emergency situations.

Flashover – Flashover occurs when all surfaces and objects within a space have been heated to their ignition temperature and simultaneously combust. Flashover can take place at the point between the growth and fully developed stages of a fire.

Backdraft – A backdraft is an explosion that occurs when oxygen enters an oxygen-deficient smoldering fire. Backdraft conditions typically exist during a fire's decay stage, after the fire compartment has consumed all available oxygen.

Rollover – Rollover takes place when pressure from the fire area pushes heated gases into uninvolved areas, causing flames to present in layers of smoke.

Stratification – Stratification occurs when fire gases separate into layers according to temperature. The gases with the highest temperatures move to the top layers, and the cooler gases move to the bottom layers. This is also called "thermal layering" or "thermal balance."

Heat release rate – A fire's heat release rate is the amount of energy the fire releases over time.

ABBREVIATIONS

The following abbreviations and acronyms were used in this manual:

- HRR – heat release rate
- IC – incident commander
- IDLH – immediately dangerous to life and health
- NFPA – National Fire Protection Association
- PPE – personal protective equipment
- RECEO VS – rescue, exposure, confinement, extinguishment, overhaul, ventilation, salvage
- RIT – rapid intervention team
- SCBA – self-contained breathing apparatus

- UL – Underwriter's Laboratory
- VSP – victim survivability profiling

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PLANNING AND PREPARATION

Personnel must be mentally and physically prepared when reporting to the fire station for duty. Some jurisdictions have established roll call or line-up procedures to prepare personnel at the beginning of their shifts, and others may utilize alternative methods to begin their workday. Regardless of the specific format employed, company officers should ensure personnel understand the roles associated with their riding positions and are accountable for the accompanying responsibilities. Officers must clearly communicate their expectations, particularly for personnel detailed into the fire station who are unfamiliar with established roles and responsibilities.

Off-going personnel should share pertinent information with oncoming shift members. Dynamics such as street closings, out-of-service hydrants or mains, inoperative standpipe or sprinkler systems, and equipment deficiencies or changes can directly affect incident operations and should be communicated to oncoming shift members.

Assigned personnel should update jurisdiction-specific administrative tracking functions such as logbooks, riding assignment boards, riding cards, and unit rosters to accurately reflect staffing at the beginning of a shift.

Personnel should also perform equipment and apparatus inspections to account for equipment and ensure it is in good working condition. Inspections should include personal protective equipment (PPE), self-contained breathing apparatus (SCBA), radios, hoselines, nozzles, hand tools, vehicle components, and pump operations.

Engine company firefighters should examine all hose loads, racks, nozzles, and appliances to familiarize themselves with how they are packed and how they will deploy. This is especially important for detailed personnel. All personnel assigned to the unit should know the location of all tools and equipment on the apparatus and verify each item’s presence at the start of each shift. Personnel should discover the absence of equipment during routine apparatus inspections rather than at an incident scene.

TRAINING

Firefighters must achieve and maintain competence in a multitude of operational skills and abilities to mitigate emergency incidents safely and efficiently. Training represents an essential component of operational competence. Through training, firefighters establish and reinforce skills and behaviors that influence and inform their operational decision making.

Fire service personnel must routinely and swiftly make multiple critical decisions. They often must base these decisions, which can result in serious consequences for those affected by them, on limited or incomplete information. Understandably, firefighters making decisions during dynamic emergency events experience stress.

During stressful situations, firefighters experience physiological changes as their sympathetic nervous system releases adrenaline and cortisol, increasing heart and breathing rates, constricting blood vessels, and tightening muscles. Under these conditions, cognitive processes often transition from classical decision making to naturalistic decision making.

In classical decision making, the decision maker follows a step-by-step, logical sequence to reach the best decision. This cognitive process includes analyzing the situation; identifying the problem; developing solutions to the problem; weighing the advantages, disadvantages, risks, and benefits of each option; and finally, choosing the option that best solves the problem.

Naturalistic decision making results from an intuitive reaction to a problem. In this process, the decision maker recognizes sights, sounds, smells, and other sensory cues that trigger memories of similar, previously encountered situations. The naturalistic decision maker quickly chooses actions based on successful past choices. This is called *recognition-primed decision making*, a widely discussed cognitive model derived from the naturalistic decision-making framework.

Although a firefighter's physiological response to situational stress cannot be controlled, it can be mitigated through training that promotes recognition-primed decision making. Appropriate and adequate training and practice can create a bank of simulated successful past actions from which the well-trained firefighter will automatically draw. Most close-call incidents result from poor performance and decisions involving basic firefighting skills, so the ability to properly apply learned techniques under pressure represents a critical aspect of incident-scene safety, efficiency, and effectiveness.

Training activities should occur as often as possible and be structured to positively influence fireground operations during stressful situations. Firefighters will lose or forget techniques they do not use or practice regularly, so repetition offers the best way to develop muscle memory and solidify learned experiences for basic technical operations. Experience, derived from a combination of real-world incident responses and purposely designed training, provides the only way to achieve the skill level needed to properly apply learned techniques in stressful emergency situations.

Fire service training falls into three categories: self-study, company training, and multiunit training. Individuals can engage in self-study training to establish or maintain their base knowledge of policies, procedures, manuals, and other reference material. Soft-copy training presentations, online programs, websites, and web-based repositories all offer acceptable resources for self-study training.

Company training should occur regularly in an informal setting and cover hands-on practical skills such as handline deployment, ventilation tactics, search-and-rescue methods, and firefighter survival topics. Company training is designed to identify company members' knowledge, skill, and ability deficiencies and correct them before the next emergency incident occurs.

Training officers should conduct multiunit training on a quarterly basis and should include neighboring and mutual aid companies. The purpose of multiunit training is to practice and coordinate general strategies and specific fireground tactics common to a structure fire. Fire department training academies can accommodate the training needs of multiple units, but training officers should also consider using target hazards and known structures within the response area for added realism.

FIRE BEHAVIOR

Firefighters must develop an understanding of fire behavior to conduct efficient and effective fire suppression operations. The method and materials used during a building's construction, as well as the building's contents, affect the way a fire behaves. A fire in a building with interior concrete block walls and significant compartmentalization may retain a lot of heat and limit fire extension. Conversely, a fire in a building with lightweight framed walls and large open spaces may create lower overall temperatures but allow significant fire spread.

Knowledge of the fire growth stages enables engine company members to strategically position hoselines and apply hose streams in a tactically optimized manner.

The Fire Tetrahedron

Combustion occurs when the rapid chemical combination of a substance with oxygen produces heat and light. For combustion to occur, each component of the fire tetrahedron must be present:

- Oxygen, which enables a fire to sustain combustion.
- Fuel, which includes any combustible material in the form of a solid, a flammable liquid, or a gas.
- Heat, which is needed to raise the fuel to its ignition temperature.
- Chain reaction, which occurs when the other three elements are present in their necessary conditions.

After combustion occurs, removal of one of these components from the reaction will extinguish the fire.

Stages of Fire Growth

Generally, the earlier a fire can be suppressed, the better. This is because fires will continue to grow in intensity, temperature, and size if they have the resources they need to burn. The National Fire Protection Association (NFPA) and standards from most other organizations classify four stages of a fire. These are incipient, growth, fully developed, and decay.

The incipient stage begins when heat, oxygen, and a fuel source combine and have a chemical reaction resulting in fire, also known as ignition. Ignition usually produces a very small fire that often self-extinguishes before reaching the subsequent stages.

The growth stage occurs as fires increase in size from areas of small flames to flames encompassing an entire compartment. This may be a rapid event that takes only seconds, or it could take hours to develop, depending on several interrelated variables:

- combustible content (i.e., fuel load, including contents and structure),
- oxygen supply that is preexisting, fire created, or firefighter created via ventilation,
- compartment size, and
- the compartment's insulating qualities.

In structural firefighting, rollover takes place during the growth stage as heated gases from the fire area push flames within layers of smoke into adjacent compartments. Firefighters should view rollover as a warning that the fire area may be reaching the point of flashover, which occurs between a fire's growth and fully developed stages. As heat radiates off ceilings and walls, it raises the temperature of smoke, gases, and combustible contents within a compartment. Flashover refers to the point when all surfaces and objects within a space reach their ignition temperature and simultaneously ignite.

During a fire's fully developed stage, fire envelopes the entire compartment, involving all contents in fire. A fully developed fire will continue to burn until it has consumed all the available fuel and oxygen in the area.

The decay stage begins when the available oxygen can no longer support combustion. As the level of oxygen falls, visible flames diminish, and the fire begins to smolder, but firefighters may still observe high heat and smoke conditions. These circumstances create the potential for a backdraft. A backdraft is an explosive event caused by the introduction of oxygen into an oxygen-deficient, high-heat, smoldering fire. Backdraft conditions typically exist during a fire's decay stage after the fire has consumed all available oxygen within a compartment. A backdraft produces violent shock waves that can shatter windows and cause walls to collapse.

Warning signs of a possible backdraft include the following:

- dense smoke with no visible flame in a tightly closed compartment,
- black smoke pushing around closed doors or window frames,
- glass stained with smoke condensation and pulsating from the fire's pressure, and
- the reversal of air movement pulling smoke back into a building through a doorway.

Residential Construction and Fuel Loading

Homes built within the last several decades are typically larger than older homes, incorporate open floor plans, and utilize lightweight truss construction methods. As the methods and materials used in residential building construction have changed, so too have residential building contents. Structures now contain an ever-increasing amount of synthetic material.

Generally, firefighters refer to these changes in building construction and contents by designating them as *modern* or *legacy*. Modern materials include man-made materials, such as plastics, synthetics, polyurethane, and polyester. Legacy materials, sometimes also referred to as "traditional materials," consist of natural materials, such as cotton, wicker, solid wood, and dimensional lumber. The difference between modern and legacy materials is significant as it relates to their heat release rate (HRR). Modern materials have a much higher HRR. Consequently, when a fire involves these materials, temperatures rise quickly, and flashover can occur much sooner than in a fire fueled by legacy materials.

Personnel should understand that given the high HRR of modern materials, uncoordinated ventilation can quickly lead to flashover. Fires involving modern materials quickly grow and produce high temperatures (see Figure 1). Engine companies must efficiently and deliberately advance hoseline and initiate fire attacks. Personnel should also expect a significantly different HRR than what they encounter during training burns.

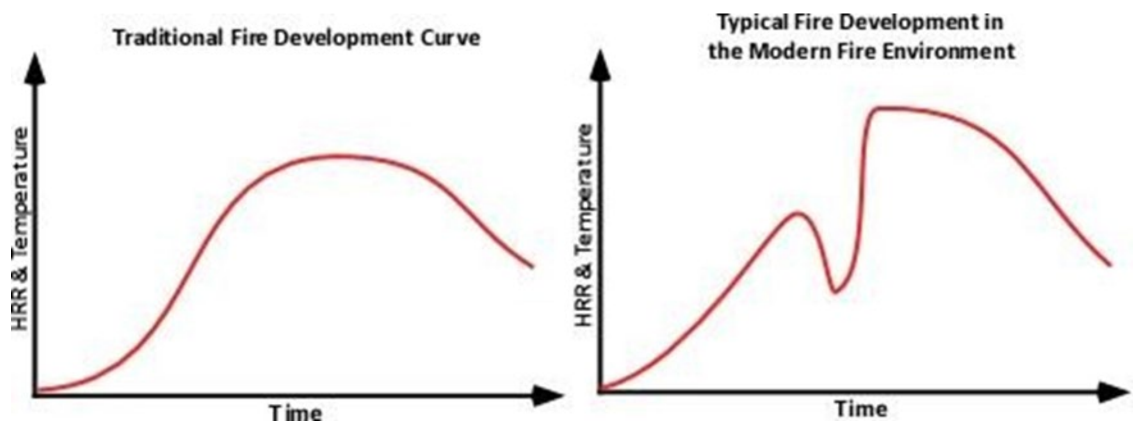

Figure 1. Legacy/traditional vs. modern fire development curves.

For successful suppression efforts, firefighters must understand how a building's contents and construction methods and materials affect a fire's behavior. The question of whether a structure contains legacy or modern materials further complicates these dynamics.

Ventilation

On the fireground, an engine company's efficacy depends on its ability to rapidly advance a hoseline and apply sufficient water to the seat of a fire. Ventilation operations can positively or negatively affect these efforts.

Engaging in coordinated ventilation of a fire compartment as personnel position a hoseline and prepare for fire attack can beneficially reduce temperatures, increase visibility, and provide an exhaust route for stream conversion. However, uncoordinated ventilation performed in an area remote from the fire compartment or before the hoseline crew is ready can hinder operational impact.

Every opening created in a building provides a path for oxygen that could dramatically change interior conditions. Firefighters should take practical actions to control openings when advancing into a structure, only ventilate areas that will benefit operations, and only ventilate in coordination with fire attack. The officer in charge of the initial attack line should communicate with outside ventilation teams to direct the timing and type of coordinated ventilation.

Smoke

Smoke refers to a collection of airborne particulates and gases emitted when a material combusts and the quantity of air these particulates and gases entrain and mix into. Smoke-filled atmospheres are toxic, flammable, and potentially explosive. The chemical composition of smoke varies with the make-up of the burning materials; however, all smoke is filled with carbon and carbon monoxide.

Smoke leaving a structure has four inherent characteristics: volume, velocity, density, and color. Individually, these characteristics indicate little about a fire; however, a comparative analysis of these characteristics can help personnel determine a fire's size and location and the potential for hostile fire events. Personnel who can rapidly interpret the smoke issuing from a building can make more appropriate tactical choices.

Volume

The volume of smoke leaving a structure indicates the amount of fuel that is "off-gassing" within a given space. Personnel must consider smoke volume in relation to other characteristics because the amount of air available, the building's interior size, the amount of available fuel, and the duration of burning can all affect the volume of smoke a fire produces.

A fire fed by sufficient air will emit very little visible smoke, and a fire in an underventilated building can produce a large volume of smoke. A small fire can quickly fill a small commercial occupancy with smoke; however, the same small fire would require a significant amount of time to fill the interior of a large "big-box" commercial occupancy.

Once smoke has filled an inadequately ventilated container, pressure begins to build. In this way, smoke volume relates to smoke velocity.

Velocity

The velocity (i.e., speed) of smoke leaving a structure provides insight into the fire's location relative to the smoke exhaust point and the status of the fire's flow path.

Smoke exiting a structure from an exhaust point close to the seat of a fire typically moves quickly, expands rapidly, and is agitated. When a proximal exhaust point does not exist, smoke flows upward toward the ceiling, where it migrates away from the fire. As the smoke expands and travels up the interior walls, across the ceiling, and through open doors, the building materials and contents absorb heat, decreasing the smoke's velocity.

Viewed from outside a building, slow-moving smoke indicates the seat of the fire is remote from the exhaust point or that the fire compartment is still absorbing heat. Fast-moving smoke indicates the fire is close to the exhaust point or that the fire compartment cannot absorb any more heat. Moving smoke indicates a growing fire with sufficient oxygen. Static smoke indicates a nongrowing fire with inadequate oxygen.

Density

Smoke *density* refers to the thickness of the emission and how much fuel is laden in the smoke. Optical density refers to how difficult it is to see through the smoke. Thick or optically dense smoke contains a high concentration of particulates and is difficult to see through. The greater the smoke density, the higher the likelihood for a hostile fire event, such as flashover or rapid-fire spread.

Knowing how to read when smoke is too thin to ignite or dense enough to burn enables personnel to more accurately evaluate flashover potential and the associated need to cool the smoke before advancing.

Color

The color of smoke provides clues about the material make-up of burning fuel. Generally, the darker the smoke, the more volatile the fire. Although fires can produce uniquely colored smoke, the following colors are typically observed:

- White
- Grey
- Brown
- Black

A fire's incipient stage typically produces white smoke as the fuel off-gases moisture and water vapor.

Grey smoke can indicate slowing fire growth as the availability of fuel decreases. Wood and other ordinary combustibles commonly produce smoke ranging from light gray to yellowish.

Brown or black smoke signals an underventilated fire. Different fuel types can produce these colors, but they typically have similar flammability behaviors.

Brown smoke can indicate that a fully developed fire is feeding off a wood fuel source. In a wood-framed building, this can mean a fire is weakening the building's structural integrity, creating a risk of collapse.

Black smoke typically signifies heavy fuel loads that are not being fully consumed. At times, black smoke can result from the burning of manmade materials such as petroleum products, rubber, and many plastics.

Reading Smoke

Figure 2 shows a large volume of moving, thick black smoke. The smoke indicates a fully developed ventilation-limited fire. The interior atmosphere was likely too rich to burn until ventilated by fire department personnel. After fire department ventilation, personnel must swiftly apply water to prevent fire spread.

Figure 2. Reading smoke, Example 1.

Figure 3 shows a large volume of moving, thin white smoke on side Alpha and a large volume of moving, thick black smoke on side Charlie. The smoke indicates a fully developed fire in quadrants Alpha and Delta (the white smoke may be the result of water application) and a substantial ventilation-limited fire in quadrants Bravo and Charlie.

Figure 3. Reading smoke, Example 2.

The fire in Figure 3 has spread to multiple compartments with extension into the attic. Fire growth within these compartments ranges from fully developed to ventilation-limited; however, the fire has adequate airflow to grow.

Figure 4 shows a large volume of moderately pushing brown smoke. The smoke indicates a decaying ventilation-limited fire, likely within the attic's Alpha and Bravo quadrants. The smoke is too rich to burn within the structure and too lean to burn on the exterior.

Figure 4. Reading smoke, Example 3.

The smoke staining on the exterior indicates high temperatures in the attic space. Initial fire attack requires coordination between water application and ventilation.

FIREFIGHTING OBJECTIVES

Personnel should prioritize the objectives of any firefight according to the acronym RECEO VS, which stands for

- Rescue
- Exposure
- Confinement
- Extinguishment
- Overhaul
- Ventilation
- Salvage

Underlying these priorities is the ever-present goal of protecting life and property while maintaining a high level of awareness throughout the incident.

A *strategy* articulates the general plan or course of action taken to reach the objectives. Strategy most often manifests in the mode of operation: offensive (interior or exterior) or defensive.

Tactics involve the specific actions employed to fulfill the strategy (e.g., a hoseline to the top of the stairs to limit fire extension and protect the search or a ladder to an upper story window).

Officers must consider many factors while developing a proper strategy and associated tactics to achieve the RECEO VS objectives, beginning with a proper and ongoing size-up. Size-up begins with receipt of the alarm and continues throughout the incident. All members should size up the incident as it relates to their specific duties. Officers should train their personnel to develop and maintain what is called *situational awareness* by not only sizing up the incident but by voicing any safety concerns.

Rescue

The rescue of life represents the primary focus of any incident. The engine officer must analyze the situation to determine the presence of life hazard. If life hazard exists, the officer must decide how to protect the victim or affect the rescue. Often, the fastest and safest action involves simply extinguishing the fire or positioning a hoseline between the victim and the fire. A rescue attempt without hoseline protection or a coordinated fire attack presents risks and should only be attempted in extreme circumstances. If the officer determines no life hazard exists, then the rescue objective can be prioritized below a more pressing issue.

Exposure

Exposures consist of interior and exterior sources. To effectively protect exposures, the engine officer must have a good idea of the fire's location and extent and the potential fire travel routes while considering methods of heat transfer and types of construction materials. The primary goal of the exposure line is to minimize fire spread and stay ahead of the fire. Often, the actions of this line will involve more than protecting exposures. The line may sweep the outside of the fire building to stop the fire from extending into the roof, or it may quickly sweep the exposure before knocking down a garage fire.

Confinement

Firefighters often overlook confinement. Most of the time, companies arrive on-scene and perform the rescue, exposure, and extinguishment components. Confinement becomes necessary in larger fires when lacking on-scene resources makes extinguishment impossible. Early in the incident, engine officers should attempt to determine if they can manage the fire with on-scene resources. If not, they should shift priority to minimizing fire spread and containing the fire until appropriate resources arrive. This scenario could occur inside or outside a structure. The goal is to hold the fire to a room, quadrant, or wing of a structure until additional resources or tactics can be utilized.

Extinguishment

Extinguishment is by far the most effective way to quickly mitigate an incident because it eliminates or improves all of the other fireground obstacles. Firefighters sometimes perform extinguishment first, even when a rescue or exposure problem exists. The engine officer must determine the fastest and most efficient method to achieve fire control. Then firefighters must work as a team to rapidly advance the hoseline, interpret fire conditions and behavior, and appropriately attack the fire. In proper extinguishment efforts, members coordinate with the ventilation teams.

Overhaul

Overhaul involves a systematic look at the entire fire scene to ensure no further traces of fire exist. Firefighters should check voids closest to the seat of the fire first, working outward until unburned material is reached. Officers must carefully weigh this step against the need for a thorough investigation. When a situation warrants an investigation, members should leave the fire room and contents as intact as possible to facilitate a more rapid and accurate inspection.

Fire officers should develop and communicate a plan for overhaul tasks. This plan should stipulate that firefighters continue to use their SCBA during overhaul to reduce exposure to toxic gases and carbon monoxide. Firefighters should thoroughly wet down overhauled materials before pulling down additional materials to avoid creating layers of overhauled debris within which a smoldering fire could develop.

Ventilation

Ventilation on the fireground can represent one of the most dangerous and important tasks firefighters perform. Horizontal ventilation involves opening or removing windows in the structure to accomplish several objectives that aid in fire extinguishment. This type of ventilation permits rapid advance of the attack hoseline to the fire area while reducing the danger of heat or fire passing over or around the nozzle team by allowing heat and smoke to escape through the newly created openings.

Critically, officers must coordinate horizontal and vertical ventilation between the inside or outside ventilation team and the advancing hose team. Uncoordinated, poorly located, or ill-timed horizontal or vertical ventilation can cause the fire to spread rapidly, subjecting personnel inside to extreme heat and flashover conditions. The introduction of any ventilation into the structure will increase fire intensity and spread. Firefighters must remain vigilant about a fire's ventilation status. Failure to recognize changes in the ventilation status can result in personnel being caught in a rapid-fire propagation or flashover event.

Before any ventilation takes place, the ventilation team must answer the following questions:

- What is the fire's location?
- What is the current ventilation status?
- Will adding additional ventilation openings affect fire conditions?
- Where is the hoseline?

Salvage

Simply stated, salvage is property conservation. Salvage limits damage from the fire or the fire control efforts and is often performed in conjunction with firefighting efforts. All personnel operating on the fire ground are responsible for loss control and property conservation efforts. However, the engine officer should ensure specific actions and tasks are performed in such a way as to minimize damage. Typically, members implement salvage measures after initial knockdown but before performing extension and overhaul operations. Some of these actions include:

- Moving or covering furniture prior to pulling ceiling or flowing water.
- Removing pictures and other valuables from the wall.
- Placing hall runners on the floor to minimize damage from foot traffic in a structure's unaffected parts.
- Relocating contents and belongings to adjacent rooms to protect them from weather if a roof has burned away.

FIREGROUND STRATEGY

In any fire, personnel operate in one of two modes. *Offensive mode* involves taking direct action to mitigate a problem. This means personnel have selected to use an interior or exterior direct attack with the goal of reaching the seat of a fire and extinguishing it. Quickly extinguishing the seat of a fire saves lives and property.

Alternatively, officers adopt a *defensive mode* to prevent damage to the area around a structure. Officers deploy defensive strategies when they have decided a building cannot be saved because of advanced fire involvement. The objective of the defensive mode is to stop the fire from spreading to savable exposures rather than focusing hoselines on an already lost building.

Within either mode, firefighters adopt strategies and tactics. *Strategy* refers to the game plan for a fire attack or operation mode, and *tactics* refers to the physical acts performed to extinguish a fire. Fireground strategies and tactics change due to various factors, often determined during size-up, and the engine company officer must react appropriately to each change.

Size-Up

After officers complete an incident's initial assessment, incident management begins. Size-up sets the foundation for incident management. Decisions made during size-up determine strategic goals and tactical objectives and identify the operations necessary to achieve those goals and objectives.

Risk Assessment

Conducting a risk assessment and employing a risk management strategy represent two of the most critical functions performed on the emergency scene. Fire officers and firefighters alike must take responsibility for safety. Threats to personnel safety come in many forms. The fire officer's primary role is to implement an action plan that best mitigates the incident while managing risk levels. The principal objectives of risk management include an internal process to identify and evaluate risks before developing, selecting, and implementing measures up front to lessen the probability of a harmful consequence.

On the fireground, fire officers and firefighters use knowledge, skills, training, and experience to successfully evaluate and minimize risk. Primary concerns include risks affecting the public followed by risks to fire service personnel. The fire department's mission is to protect life and property. Threats to safety on the fireground primarily come from two categories:

- advanced fire conditions and
- collapse potential.

To assist with the risk assessment, firefighters must answer several questions:

1. What is the life hazard?
2. What are the fire conditions?

3. What is the potential for victim survival, or what is the victim survivability profile?
4. What is the structural stability and potential for collapse?
5. Do I have adequate resources to make a positive impact on the incident?

Life Hazard

Firefighters must determine if civilians are trapped or possibly trapped. Sometimes this information comes clearly from a dispatcher on the phone or from a family member reporting on-scene. Other times, the status of possible victims comes from a neighbor's account or time of day and cars in the driveway.

Knowing the life hazard potential is critical when determining and managing risk.

Locating the Fire

The initial engine company officer often takes responsibility for locating a fire inside a building. The officer accomplishes this task through an incident size-up based on observation, experience, and information from the building's occupants and the dispatcher (after speaking with the 911 caller).

During the size-up, unit officers should complete a 360-degree lap of the structure. The use of a thermal imaging camera during this lap can help determine the location and intensity of the fire. Firefighters and officers operating in an immediately dangerous to life or health (IDLH) environment must pay attention to smoke behavior to successfully locate and extinguish a fire. Officers can assess exterior and interior clues to help them determine a fire's location.

Smoke can indicate a fire's location, and smoke velocity represents the most reliable indicator of a fire's location. Smoke rising or exiting the building quickly and under pressure indicates that the smoke is close to the heat source, thus narrowing down the possible locations. Smoke volume is not a good indicator of a fire's location.

Looking at the windows of a structure can give personnel an indication of a fire's location. Dark-stained windows may indicate the location of the fire. Dark windows should be further investigated and checked for heat. Dark windows may also indicate a fire in the decay stage with limited ventilation. Carefully coordinated ventilation and fire attack must be employed in this situation. Crazed or cracked glass also indicates intense heat inside the fire room, which indicates the fire's location.

How far smoke has banked down on a particular level can provide significant information to companies. Smoke typically travels upward. When smoke is encountered from floor to ceiling, companies must check the floor below that location. Frequently, this condition indicates a basement fire or a fire in the decay phase with limited ventilation. The smoke has had time to cool off and calm down, thus creating a floor-to-ceiling smoke scenario. After confirming that the floor below is clear, the fire officer should look for a compartment with an increase in heat to locate the fire. Carefully coordinated ventilation should also be used with direct communications between the fire attack team on the interior of the structure and the ventilation team on the exterior.

The movement of smoke or air in a structure's interior can serve as an excellent indicator of the fire's location. Smoke and products of combustion exhaust (i.e., move away) from the fire at the ceiling level. The fire draws in fresh air at the floor level to support combustion. Firefighters and fire officers can use this draw of fresh air at the floor level to track down a fire location. The light smoke between the floor and the heavier ceiling smoke typically travels toward the fire's seat. The speed of movement serves as a good indicator of the fire's intensity and its proximity to the fire's location.

Smoke lift also presents an effective way to gather information regarding the fire's location. When the companies open the door at a point of entry, they create a ventilation opening, providing additional air to the fire. Lift occurs when the smoke level rises, increasing the depth of clean air at the floor level. Together, the rate and amount of lift provide information about the fire's intensity, floor level, and ventilation status. After opening the door at the point of entry, members should pause to observe the smoke's conditions before advancing. Smoke conditions indicate the direction of the fire.

After opening the entry door when floor-to-ceiling smoke conditions exist, smoke often pours out of the opening at the top, rapidly lifts, and begins to draw in at the bottom. When this occurs, it may indicate the presence of a significant fire that is relatively close to the point of entry, on the same level, with limited ventilation. The chance of rapid fire propagation is high, and companies must be prepared for rapid fire development.

If smoke lazily or barely exhausts and lifts after opening the entry door, this may indicate a fire located farther away from the point of entry that is less intense or located on the floor below.

Listening can provide useful information about a fire's location. Fires that are vented or free burning typically make the most noise. Fires in the decay stage may not produce any noise. Any fire that is actively burning will produce cracking and popping sounds that the firefighter can use to determine the fire's location. Crews operating on the interior should occasionally stop and hold their breath for several seconds and listen for the sounds of the fire. Crew members operating near one another may need to coordinate in holding their breath so that the inspiratory and expiratory sounds of SCBA breathing do not overpower the sound of the fire.

Fire Conditions

Current and projected fire conditions, along with the building construction type, give personnel significant information to use when determining the timeframe in which they can act. Large-volume fires in combustible buildings increase the risk and decrease the time to act, and smaller fires in noncombustible buildings decrease the risk and increase the time to act. Understanding fire behavior and travel, as they relate to the various building construction types, represents one of the most important tools firefighters and fire officers can use when assessing and managing risks related to fire conditions.

Protection of Life

Engine companies are often faced with the decision of how to protect life during firefighting operations. Factors to consider include the fire's location and advancement, state of the victims, status of the victims' environment, and the victims' physical location within the structure. In most cases, the engine company should identify the fire's location and extinguish the fire as rapidly as possible because conditions improve when fire is extinguished. If victims reside on the fire floor and they can be protected in place or removed from the structure, then personnel must coordinate this action as the attack line moves into position to confine the fire. If people are trapped, resources must be committed to those areas to protect trapped victims in place by extinguishing or confining the fire until the victims can be rescued, even if it means that the fire will spread to other parts of the structure. In all cases, the engine company officer must complete a risk assessment to determine if victims are viable and rescues can be made.

Victim Survivability Profiling

Victim survivability profiling (VSP) is a term that the fire service has used for many years. It may less commonly be referred to as *occupant survivability profiling*. The core concept of VSP is that firefighters must conduct a thorough size-up of a structure fire to determine the likelihood of a victim's rescue potential.

Personnel must understand the following three factors regarding the human body's physiology to conduct the VSP:

- The human body's threshold for heat. The NFPA suggested that the upper range of temperature tenability for humans is approximately 212 ºF.
- Carbon monoxide. The primary cause of fire-related death is carbon monoxide poisoning. A carbon monoxide density of approximately 200,000 parts per million renders the human body unconscious within 4–12 s, with death following shortly thereafter.
- Oxygen. The Earth's atmosphere contains 21% oxygen. Percentages of less than 10 rapidly result in death.
- Other toxic fire gases, such as cyanide. Today's fires produce a tremendous amount of toxic gas that can rapidly incapacitate and kill fire victims.

With an understanding of the human body's response to fire conditions, combined with a size-up of the structure and information about the location and extent of fire, the engine officer determines the best course of action for mitigating the emergency. Modern fire behavior studies have also supported the idea that the chances of survival can be greatly increased by shutting a door and creating a barrier between the compartments. The 2010 UL study, *Impact of Ventilation on Fire Behavior in Legacy and Contemporary Residential Construction*, demonstrated that conditions remain tenable for both temperature and oxygen thresholds in a compartment with a closed door.

VSP provides firefighters with an excellent tool for use during size-up. Personnel should exercise caution when drawing conclusions regarding victim viability based on the profile alone.

Structural Stability and Collapse Potential

Personnel must consider whether a building has the potential to collapse. If personnel suspect a risk of collapse, they must determine how long crews can operate before collapse, if a safe zone exists that crews can operate within to decrease the risk, what part of the building will collapse first, and how operations will be affected. Incident Command (IC), officers, and firefighters must consider these kinds of questions throughout each incident. As a general rule, large spaces and spans threaten firefighter safety. Large box stores in the commercial arena, large span trusses, and concentrated loads in lightweight building construction present the highest risk to firefighters. Crews should adjust operations as necessary to avoid these high-risk areas. Operating from smaller or adjacent compartments will oftentimes substantially decrease risk and increase firefighter safety.

Size-Up Examples

Figures 5–11 provide size-up examples, and Tables 1–7 provide corresponding details about life hazard, fire conditions, survivability, structure stability, and resources.

Figure 5. Size-up, Example 1.

Table 1

Size-Up, Example 1

Size-up factor	Description
Life hazard	Probable given time of event and no occupants present on arrival
Fire conditions	Advanced fire conditions throughout entire structure
Victim survivability profile	No survivable victims due to advanced stage of the fire
Building construction	Lightweight, wood frame construction, stability compromised all levels
Initial tactics	Fire conditions limit ability to safely execute interior operations.
Summary	Establish water supply, exterior fire attack Risk assessment of the building based on the construction type, fire conditions, resource availability, and time of day should all be critical consideration factors before any change in tactics

Figure 6. Size-up, Example 2.

Table 2

Size-Up, Example 2

Size-up factor	Description
Life hazard	Probable given the time of day, vehicle in driveway, and no occupants present on arrival
Fire conditions	Advanced fire conditions throughout roof structure with spread to the living space
Victim survivability profile	Survivability is high—Minimal smoke or fire in the living space, and a person could still be inside and unaware (asleep, basement area)
Building construction	Lightweight, wood-frame construction, structural stability of roof and attic compromised
Initial tactics	Candidate for blitz attack
Summary	Establish water supply, quick knockdown from the exterior with a large-caliber line, interior attack after the bulk of the fire has been knocked, and structural stability is ensured, ground ladders may have to be utilized to access the upper compartments due to fire in stairwell.

Figure 7. Size-up, Example 3.

Table 3

Size-Up, Example 3

Size-up factor	Description
Life hazard	Probable given time of event and no occupants present on arrival
Fire conditions	Advanced fire conditions in the attached garage
Victim survivability profile	Survivability high—Minimal smoke or fire in the living spaces, and a person could still be inside and unaware of the event
Building construction	Lightweight, wood-frame construction, structural stability compromised in garage
Initial tactics	Blitz attack
Summary	Establish water supply, quick knockdown from the exterior with a large-caliber line, interior attack can be attempted once the bulk of the fire has been knocked down

Figure 8. Size-up, Example 4.

Table 4

Size-Up, Example 4

Size-up factor	Description
Life hazard	Probable given the time of day, vehicles in driveway, and no occupants present on arrival
Fire conditions	Fire conditions in a lower-level compartment, no obvious fire on first floor, and large volume of smoke throughout the building
Victim survivability profile	No survivable victims due to fire intensity in the basement and smoke throughout all levels
Building construction	Conventional, wood-frame construction, stability of first floor joist questionable
Initial tactics	Interior attack on the level of the fire with a continuous evaluation of the structural stability
Summary	Establish water supply, interior fire attack basement, confirm stability of first floor prior to interior operations on first floor

Figure 9. Size-up, Example 5.

Table 5

Size-Up, Example 5

Size-up factor	Description
Life hazard	Probable given time of event and no occupants present on arrival
Fire conditions	Upper floor, multiple compartments
Victim survivability profile	Survivability moderate—Smoke in the living spaces on upper levels and minimal or absent on the lower levels
Building construction	Lightweight, wood-frame construction, structural components not compromised yet
Initial tactics	Interior attack on the upper levels with a continuous evaluation of fire spread
Summary	Establish water supply, interior fire attack If fire attack is not rapid, personnel will need to consider the possibility of fire spread to the attic space

Figure 10. Size-up, Example 6.

Table 6

Size-Up, Example 6

Size-up factor	Description
Life hazard	Probable given time of day and occupancy type
Fire conditions	Throughout box with extension through the roof
Victim survivability profile	Survivability low in fire unit—Smoke/fire throughout the box. Survivability in exposures high
Building construction	Noncombustible, stability of façade, roof, and web-bar joist questionable
Initial tactics	Candidate for blitz attack
Summary	Establish water supply, quick knockdown from the exterior with a large-caliber line An interior attack should only be attempted once the bulk of the fire has been knocked and structural stability is ensured

Figure 11. Size-up, Example 7.

Table 7

Size-Up, Example 7

Size-up factor	Description
Life hazard	Probable given time of day and occupancy type
Fire conditions	Compartment fire with possible extension
Victim survivability profile	Survivability moderate—Vented room and contents fire
Building construction	Ordinary, structural components not compromised yet
Initial Tactics	Interior attack
Summary	Establish water supply, attempt rapid interior attack on the upper level, ground ladders may have to be used to access the upper compartment

Ongoing Size-Up

As the fire attack progresses, so should the incident size-up. Personnel must assess the efficacy of the initial operation mode and associated strategy and tactics to inform the IC's subsequent incident mitigation assignments. All personnel in both interior and exterior operating crews should conduct ongoing size-ups throughout their time on the fireground.

When conducting an ongoing interior size-up, crews should assess the victims' condition and location, the fire's status, the effectiveness of fire attack, the condition of the building's structural components, hazards encountered, hoseline positioning, search area prioritization, and the condition of interior firefighting crews.

When conducting an ongoing exterior size-up, crews should reassess the fire's location, the presence of victims, and exterior obstacles that may impede fireground operations. Personnel should pay close attention to changes in smoke and structural stability. Company officers should reconcile current incident observations with those described by the first-arriving officer during their situation report to identify significant changes to incident dynamics.

Officers engaged in both interior and exterior operations who observe significant incident changes should communicate them to Command in the form of progress reports. The conditions, actions, and needs (CAN) report provides an easy way to answer or transmit progress. By using this report model, the reporting person easily identifies how well the team is doing, the conditions faced, and any support or resources needed.

Conditions:	"We have a fire on the second floor in quadrant alpha."
Actions:	"We have one hoseline in place knocking down the fire and the truck is performing a primary search."
Needs:	"We do not need any additional resources on the fire floor now."

Ongoing size-up continues after the fire has been knocked down to inform the IC of overhaul and salvage operations, carbon monoxide levels in the structure, and other pertinent issues.

Transition

After members have developed and implemented initial strategies, ongoing size-up will eventually show that incident conditions have changed. These changes can be positive results of firefighters' mitigating actions or negative results from severe incident conditions or ineffective fireground operations. Transition occurs when officers make a strategic change from offensive to defensive mode or vice versa. The IC or company officers determine when incident dynamics no longer align with the current operation mode.

If initial arriving units find a well-advanced fire extending to exposures, officers may deem a defensive operation mode appropriate. After addressing fire extension, personnel could transition to an exterior offensive mode with the potential for a subsequent interior offensive attack if structural stability has been determined.

When firefighters have initiated an offensive interior attack and suppression operations have not successfully addressed fire growth, a transition to an exterior offensive or exterior defensive mode of operation becomes appropriate. This transition may be required for various reasons (e.g., building construction, heavy fire loading, underestimation of the amount of fire, or a lack of water).

An officer’s decision to transition to a defensive strategy does not always represent a permanent operational change with no possibility of reentering the structure or returning to an offensive mode. Some circumstances on the fireground may dictate transitioning to a temporary defensive strategy with the purpose of reengaging an offensive interior attack.

For instance, if personnel cannot position interior hoselines to attack the seat of the fire and consequent fire growth creates untenable interior conditions, withdrawing personnel from within the structure to apply large-caliber exterior hose streams can facilitate a return to interior offensive positions if enough fire has been extinguished and structural stability is confirmed.

Personnel must remember that changes in operational modes are often temporary. Firefighters should always be prepared to reenter a structure after transitioning from an offensive to a defensive strategy. The transition to a defensive strategy provides an excellent opportunity for the officer to review the building from the exterior, noting smoke and fire conditions, ladder placement, and alternative attack points. This information can help the officer determine whether the transition from offensive to defensive will be permanent or temporary.

Withdrawal

Interiorly operating units utilize a withdrawal during the transitional period between offensive and defensive strategies. A withdrawal involves the coordinated and specific relocation of units and their equipment from an area deemed untenable to a specific area deemed safe for continued operations.

Withdrawals do not always require relocation from an interior to an exterior position. Incident conditions and structural circumstances may only require a withdrawal of interior units from a second-floor position to a first-floor position.

Typically, engine companies exit from the top down, assuring all other working crews accompany them in a controlled fashion. Engine company officers should ensure all personnel, hose, and equipment accompany them when relocating to a safe position.

Upon ordering a withdrawal, Command should perform a personnel accountability report. The engine officer should be prepared to report to their appropriate supervisor. Engine company officers should also check their crew’s air supply and physical condition. Personnel must remain in a safe area and be prepared to quickly reenter the immediate fire area when ordered. If the crew cannot reenter immediately upon request, the engine officer should advise the IC as soon as possible.

Emergency Evacuation

An emergency evacuation differs from a withdrawal because the emergency evacuation has a higher degree of urgency. Command should announce an emergency evacuation when conditions dictate the immediate evacuation of all personnel from an unsafe structure or other dangerous areas. The evacuation order may be given verbally, signaled over the radio with evacuation tones, blasted over on-scene apparatus airhorns, or a combination of all three. Engine companies that have evacuated and are outside of the IDLH area should continue to staff handlines until all personnel have evacuated the structure. In this position, the engine companies can support the evacuation of personnel and continue to deploy hose streams on visible fire.

ENGINE COMPANY TACTICS

A water supply plan is essential to a positive outcome on the fireground. Not only should the first-arriving engine officer formulate a plan, they must clearly communicate it to other responding units. The following sections describe options for securing a water supply.

Own Water

The engine officer secures their own water when they deem a hydrant close enough to their optimal apparatus positioning for the incident to directly hook up to a hydrant without using a supply engine. Announcing "own water" will redirect the second due engine from the hydrant, so the engine officer must consider distance from the water source, elevation, and friction loss to ensure adequate fire flow.

Forward Lay

The first-arriving engine performs a forward lay, or a laying out, by dropping a supply line at a hydrant before arriving at the incident location (see Figure 12). This action places a supply line at the closest hydrant preceding the incident, allowing another engine company to utilize that line to secure a positive water source for the first-arriving engine.

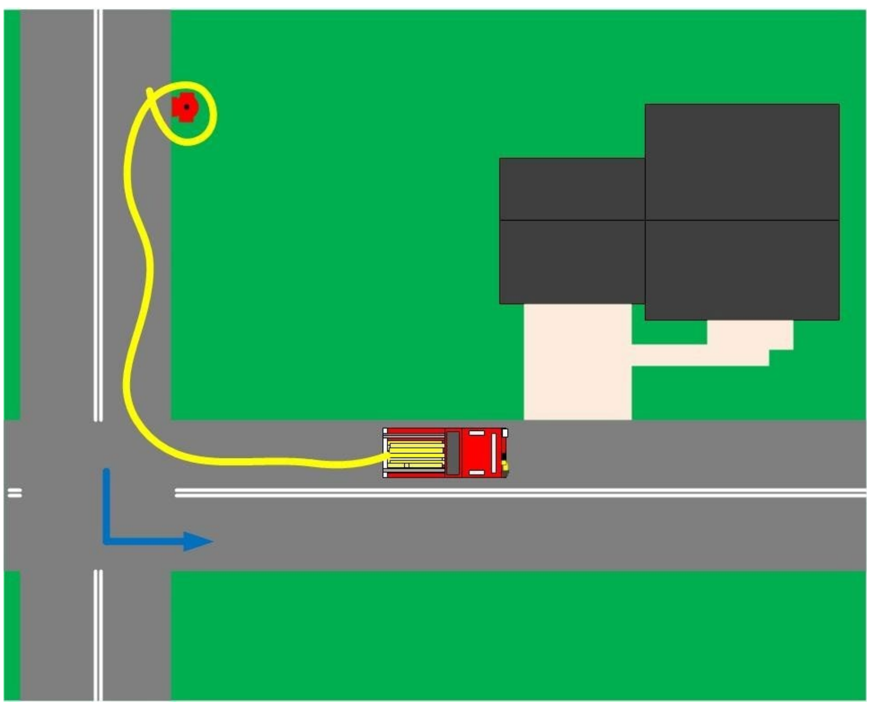

Figure 12. Forward lay.

Split Lay

The first-arriving engine performs a split lay (see Figure 13) when an incident resides at or near an intersection, the incident address has a long driveway, or other restricted access areas exist. In a split lay, the first-arriving engine drops a line at an intersection and announces the drop, naming the two intersecting streets. This announcement directs the next-arriving engine to continue the split to the hydrant on the second street. Depending on total hose-lay distance, this operation can insert a third engine into the split to perform a relay operation if necessary.

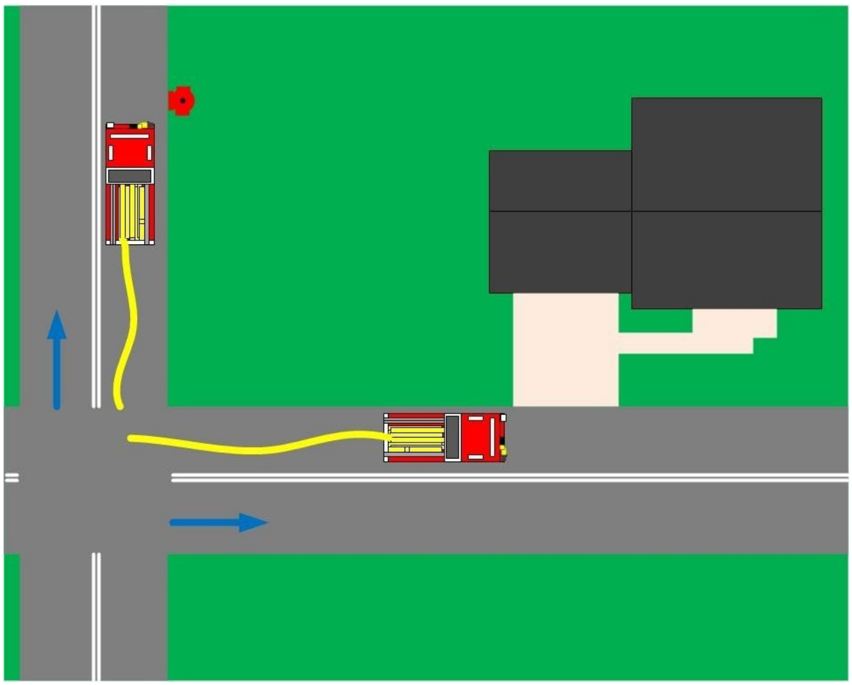

Figure 13. Split lay.

Reverse Lay

Engine companies perform a reverse lay when the second-arriving engine drops supply line at the first-arriving engine and proceeds to the hydrant (see Figure 14). The response area will dictate the feasibility of this water supply option. Narrow streets, street parking, or poorly positioned first-arriving units may prohibit the supply engine from passing the incident.

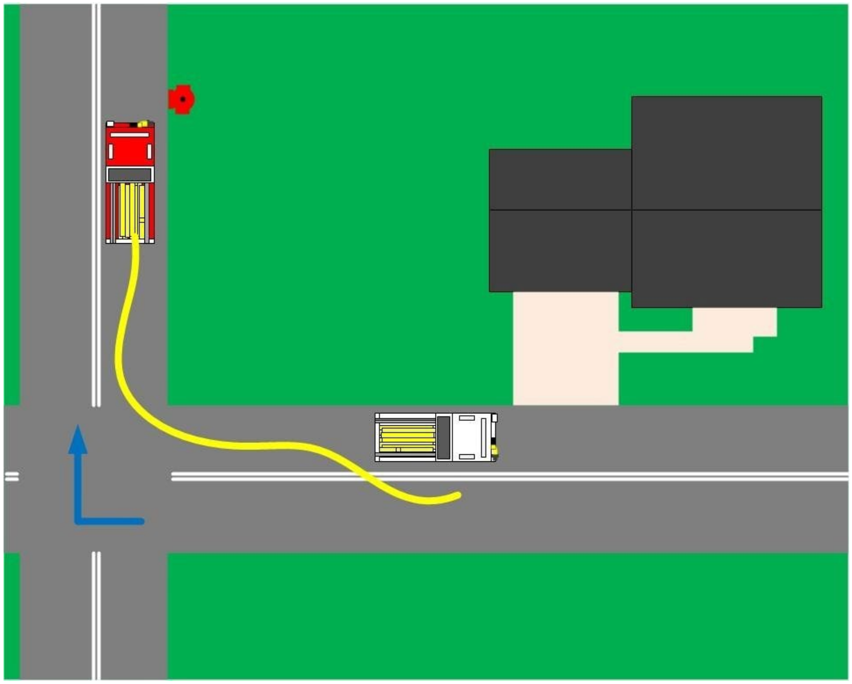

Figure 14. Reverse lay.

Rural Water Incidents

For rural water incidents, the first-arriving engine officer still must announce a water supply plan. Additionally, supply line must be laid out from a feasible location for an engine or tanker to supply from a static source, whether that be a relay operation or a dump site. For more information on rural water operations, refer to the latest edition of the NOVA *Water Supply for Suburban and Rural Firefighting* manual.

Hoseline Selection

Stretching and operating hoselines is the engine company's primary function. Efficient deployment, appropriate positioning, and effective application of fire streams save more lives and conserve more property than any other fireground operation. Firefighters can control and extinguish most fires through the initial attack line if they deploy it quickly and efficiently. The initial hoseline's success will most often define the incident's success.

When arriving at the scene of a structure fire, first-arriving company officers must determine which hoseline to use. They will base this decision on information gathered during their incident size-up and through consideration of multiple factors, including the fire's size and location, the type of building on fire, the amount of hose needed to reach the fire, and the initial strategy and tactics that will be used.

A fire's size and intensity determine the flow required to extinguish it. Most residential fires require a fire flow rate of between 100 and 200 gpm, making the 1 3/4" hoseline an appropriate selection for these fires. When compared to the larger and heavier 2 1/2" hoseline, the 1 3/4" hoseline is easier to advance up stairways and through cluttered residential rooms.

The 2 1/2" hoseline is typically appropriate for fires in commercial buildings, exterior attacks, and exposure protection. It achieves flows ranging from 200 to 325 gpm. Stretching and advancing a 2 1/2" hoseline often requires two companies and up to six firefighters.

Ultimately, the engine company office takes responsibility for hoseline selection on the fireground; however, all engine company personnel should be able to assess incident conditions and select and deploy the appropriate hoseline.

Estimating the Stretch

After determining the fire flow required for extinguishment, personnel must then select a hoseline of sufficient size with a nozzle capable of achieving the desired fire flow. This hoseline must be preconnected to—or able to be extended by—enough hose to advance to the seat of the fire.

The process of determining the needed length of hose is called *estimating the stretch*. Accurately estimating the stretch can help personnel avoid two common fireground errors, stretching short and overstretching.

If a stretch is short, the attack line and nozzle will fall short of the fire. Stretching short results in the following circumstances:

- delayed extinguishment,
- fire growth and possible extension,
- delayed search operations, and
- reduced survivability of trapped occupants.

In addition to simply lacking enough hose, stretching short can result from inefficient techniques. For example, a hoseline of sufficient length that is not properly tended can become tangled and snagged during advancement, hindering it from reaching the seat of the fire.

Overstretching occurs when a company deploys excessively more hose than is needed. Overstretching can also delay hoseline advancement as backup firefighters have more hose to tend and the unneeded hose increases the potential for snagging and kinks.

A fast and effective method of estimating the stretch involves the following formula:

Setback + width of building + length of building + 1/2 length (25 ft) per floor + 1 length at the point of attack

Engine company personnel should develop the ability to quickly estimate hose stretches visually (see Figure 15). Upon arriving on the fireground, no time exists to measure or pace off the setback or the fire building's dimensions. Response area knowledge developed through practical training and preincident planning can greatly improve a firefighter's ability to quickly estimate hose stretches.

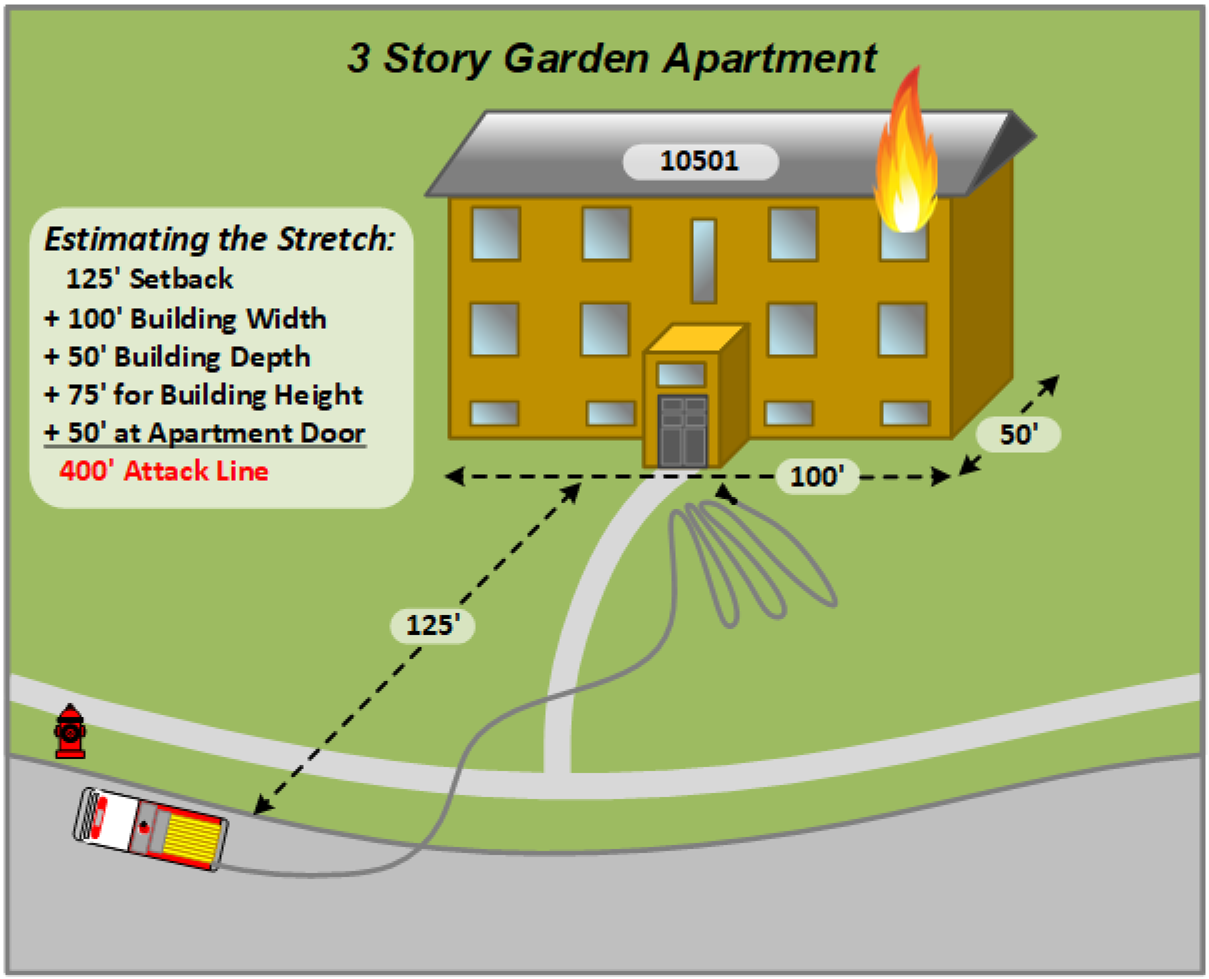

Figure 15. Estimating the stretch.

Setback

Setback refers to the distance from an engine company to the fire building's entrance.

The following inherent environmental features can help when estimating this distance.

- The average residential roadway width is 12 ft.
- The modern single-vehicle driveway is approximately 12 ft wide by 25 ft long.

- The average sedan or sport utility vehicle is approximately 6 ft wide by 15 ft long.

Obstacles between where an engine company positions and the fire building's entrance (e.g., parked cars, fences, landscaping, decks, porches, and general yard clutter) may prevent a direct path for hose deployment and create a more challenging hose stretch. Working around such obstacles will add to the length of hose needed to reach an objective, sometimes preventing a preconnected line from being effective without the addition of extra hose lengths.

Building Dimensions

An estimate of a building's length and width can provide insight into how many feet of hose will be required to reach all areas of an individual floor. Fifty feet of hoseline can cover each floor of a typical NOVA single-family dwelling with 30 ft of distance from side Alpha to side Charlie (i.e., length) and 40 ft of width on side Alpha.

One-Half Length (25 ft) Per Floor

Personnel should estimate the need for 25 ft of hoseline (i.e., one-half the length of a 50 ft section of hose) to reach every floor above or below the level of entry.

To accurately estimate the amount of hose needed to reach a fire on the third floor of a 20-ft wide, 40-ft deep, three-story, midunit townhouse, engine company firefighters should incorporate the distance of the engine company's setback, 50 ft of hose to cover the square footage of the third floor, and 50 ft of hose to travel from ground level to the third floor into their calculations.

One Length at Point of Attack

One length refers to a 50 ft section of attack line intended to stretch beyond the seat of the fire. This provides enough line to advance beyond the seat should fire extension occur or more involvement exist than initially thought.

Hoseline Deployment

After determining the required fire flow and the length of hose needed to reach the seat of the fire, engine company personnel must then deploy their hoseline.

Each engine company member should understand their role when tasked with deploying a hoseline. If individual departments do not assign riding-position-specific responsibilities, then engine company officers should clearly communicate and assign hose deployment roles before responding to an incident.

A team of two firefighters can efficiently deploy a hoseline by organizing the required responsibilities into two roles: the nozzle firefighter and the backup firefighter.

The nozzle firefighter's responsibilities include the following:

- Conduct a size-up and stretch estimate.
- Select the appropriate size attack line and nozzle under the direction of the officer in charge.
- Determine line placement to start the attack under the direction of the officer in charge.
- Begin the stretch incorporating efficient deployment techniques.

The responsibilities of the backup firefighter include the following:

- Ensure all hose is deployed from the hose bed.
- Tend hose as it is deployed to reduce kinks.
- Identify and address obstacles to reduce hose snags and kinks.
- Assist with hoseline advancement by moving hose into the building.

Ultimately, no line should be completely stretched until the officer identifies and confirms the fire's location. The nozzle firefighter must maintain discipline and hold the shoulder load until the entrance is confirmed.

The following section outlines several hose deployment techniques. Similar to hoseline selection, members determine which hose deployment technique to utilize based on information gathered during incident size-up. This decision is influenced by multiple factors, including the amount of hose that will be needed to reach the fire and the building characteristics.

Accordion Forward

Nozzle firefighters often approach their entry point with hose remaining on their shoulder. If space permits, the firefighter may be able to employ a technique referred to as the *accordion forward* (see Figure 16). This technique incorporates a planned deployment of shoulder-load hose before arriving at the entry point.

If the nozzle firefighter who is using accordion forward has 100 ft remaining on their shoulder, the nozzle firefighter will need to deploy that hose approximately 30 ft from the entry point or hose drop point.

Figure 16. Accordion forward stretch.

The nozzle firefighter accomplishes the accordion forward stretch by forecasting the need to deploy the remaining hose on their shoulder, grasping the nozzle with their hose-side hand, and grasping the halfway point of the shoulder load with their opposite hand. Once the nozzle firefighter has grasped the nozzle and halfway point of the shoulder load, the nozzle firefighter drops the remaining hose off their shoulder. While dropping the remaining hose, they must maintain their grasp on the nozzle and halfway point of the shoulder load. The nozzle firefighter must maintain these holds until arriving at the entry point or hose drop point.

Once complete, the accordion forward stretch will lay the hose out in a "Z" configuration. For instance, with 100 ft remaining on the nozzle firefighter's shoulder, the nozzle and first coupling will end up next to each other at the entry point.

V-Split

If the nozzle firefighter arrives at the entry point or hose drop point with hose remaining on their shoulder, they may employ a technique referred to as the *v-split* (see Figure 17). The v-split is a versatile method of hose deployment firefighters can apply to areas with short setbacks or open spaces. Unlike the accordion forward technique, the v-split does not require the nozzle firefighter to have the foresight to deploy the hose before arriving at the entry point or hose drop point.

Figure 17. V-split hose drop.

To accomplish the v-split, the nozzle firefighter grasps half of the shoulder load with each hand and splits the load. The firefighter should grasp the nozzle half of the load with their hose-side hand and grasp the other half of the load with the opposite hand. Once the firefighter has grasped both halves of the shoulder load, they should separate the halves. Upon separation, the firefighter can lay the hose down in a manner that resembles a "V."

Depending on the space available, the firefighter may walk the halfway point (the vertex of the "V") backward to flake the line (see Figure 18). If space permits, the firefighter can then bring the halfway point forward to align with the nozzle. When encountering short setbacks, the firefighter can grab a fold of hose from each half of the shoulder load to flake the line in the available space. Firefighters should be mindful that while shortening the depth of the stretch, the width of the stretch will increase.

Figure 18. Backward flaking of a v-split hose drop.

Reverse Stretch

The accordion forward and v-split methods involve deploying hose to a known fire location. In complex buildings with an unknown fire location, firefighters may employ the *reverse stretch*. The reverse stretch prevents engine companies from blindly stretching to an unknown fire location and allows them to start the hose stretch as soon as the fire is located. Utilizing the reverse stretch allows engine companies to locate the fire and stretch hose from a proximal area of refuge back to the apparatus.

Firefighters accomplish the reverse stretch using hose packs or fire hose disconnected from the apparatus and carried by engine companies as they locate the fire. Once they locate the fire, the stretch begins from the fire location back to a pumping apparatus. Building size and configuration will determine the most tactically advantageous location from which to begin the reverse stretch. Examples of how to accomplish the reverse stretch include the following:

- The engine company reverse stretches hose back to the apparatus through the door of entry.
- The engine company reverse stretches hose back towards the door of entry while having the engine driver stretch a prescribed length of hose into the door of entry. This effectively combines a reverse stretch and a stretch from the apparatus.
- The engine company directs a separate engine company to position in proximity to a different, more tactically advantageous point of entry and performs either of the methods described in the first two bullets.
- The engine company drops hose out of a window and has a prescribed length of hose stretched to the area beneath the window.

Standpipe Stretches

When utilizing the standpipe system in standpipe-equipped buildings, engine companies will generally encounter one of two conditions: a dirty, smoke-contaminated hallway or a clean hallway. Due to building design and features, unless the fire apartment door is left open, most fires encountered in these buildings will involve a clean hallway. The clean hallway allows engine companies the advantage of utilizing the fire floor hallway to lay out the hose.

The first step to a stretch from a standpipe matches that of any other fire: locate the fire. Once members have located the fire, the engine company can accurately select and connect to a standpipe outlet.

Clean Hallway

In a clean hallway with a controlled fire apartment door, members can begin the hose stretch by bringing the nozzle hose pack to the fire apartment door (see Figure 19). The nozzle firefighter should deploy the hose pack toward the standpipe outlet. Simultaneously, the backup firefighter should deploy the additional hose pack from the outlet to connect to the nozzle pack. Once the firefighters have connected the hose packs, they can open the outlet and adjust pressure and flow accordingly. In this situation, the firefighters must maintain control of the fire apartment door until the hose has been charged and flowed to verify appropriate flow and pressure. If the building has an elevator, members must take all possible measures to ensure they do not flow water toward the elevator lobby, potentially interrupting elevator service.

Figure 19. Reverse standpipe stretch in a clean hallway.

Dirty Hallway

Although less common than the clean hallway stretch, the dirty hallway stretch presents significantly more challenges (see Figure 20). Prior to committing to the fire floor, the engine company must charge their hoseline to the appropriate pressure and flow. Getting the hose to the fire's location is labor intensive and requires additional personnel. Also, the manner in which firefighters lay out the hose will significantly help or hinder this operation.

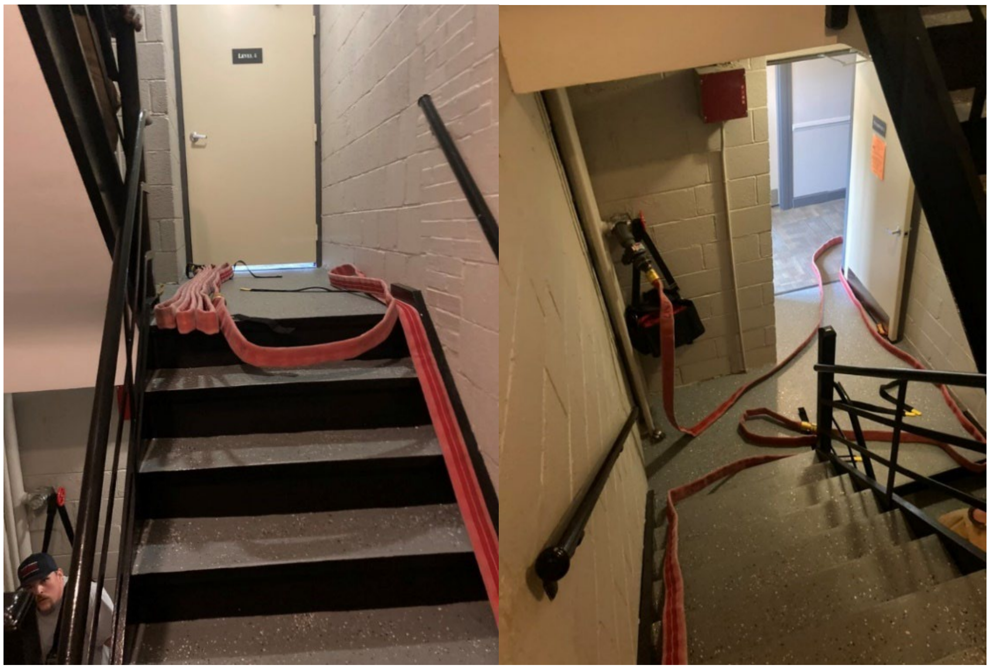

Figure 20. Dirty hallway standpipe stretch.

In standpipe-equipped buildings, the stairways often serve as the "highways" to all areas of the building. Consequently, stairways often become congested with fire service personnel and civilians. As such, the practice of utilizing the stairways to lay out hose packs has several disadvantages. Additionally, stairways contain a significant number of 180-degree bends that must be navigated when laying a hose stretch in the stairway. The number of turns coupled with the pressure limitations of standpipe systems make this practice extremely susceptible to kinks.

Instead, laying the hose out on the floor below the fire offers several advantages. With the exception of a reverse stack effect condition, the floor below the fire is likely free of smoke, offering a better work environment. In many residential occupancies, room numbers are stacked, so the floor below can provide clues to the layout of the fire floor and apartment. The space available on the floor below, particularly in center hallway buildings, minimizes the number of 180-degree bends in the hose layout.

Additionally, this approach requires only one width of hose in the stairway, greatly improving egress, access, and hose advancement. Firefighters must position at all friction points to facilitate hoseline advancement. If conditions permit, members can assist with hose advancement by advancing hose to one landing above the fire floor. Members can advance the hoseline to the fire floor once it has been charged, flowed to verify the appropriate pressure and flow, and personnel are positioned to facilitate the advance. The nozzle firefighter should be prepared to operate the nozzle as soon as the stairway door is opened.

Second Line

The initial hoseline must be operational before members deploy additional hoselines. When the initial hoseline crew encounters operational challenges, subsequently arriving engine companies should help the initial hoseline deploy, advance, or attack the fire. Rather than two engine companies struggling concurrently to deploy two hoselines, they should collaborate to establish the first line, potentially eliminating the need for a second line.

All companies must ensure the primary hoseline is in place and progressing before deploying any other hoselines.

The objective of the first hoseline determines where the second line is needed. Deciding on whether the second hoseline is for egress protection, exterior knockdown, or interior extinguishment will determine where this line is placed. Members could use the second line as an interior attack line while using the first line to attack fire on the structure's exterior. Or they could use the second line to protect the stairwell while operating the first line in the basement. Tactical communication facilitates the effective deployment of the second hoseline.

To minimize the number of lengths required and provide for rapid hoseline positioning, personnel must also consider using the following:

- a well-hole stretch,
- a ground ladder stretch, and
- a utility rope hoisted up the building's exterior.

Firefighters must chock all doors through which they stretch dry hoselines to prevent the hose from running under the door. The preferred method is to chock doors low so personnel can quickly remove chocks while retreating under advancing fire conditions.

Fire Streams

Engine companies in the NOVA region are equipped with a variety of firefighting hose and nozzle types. Each combination of equipment creates a hoseline with specific characteristics and capabilities. Departments should equip engine companies with hose and nozzles that can achieve the desired flow rates. Generally, 1 3/4" hoselines can deliver 150–200 gpm, and 2 1/2" hoselines can deliver 250–330 gpm. Members may use two-inch hose as an intermediate-sized hoseline to deliver flows between 200–250 gpm.

In the NOVA region, most firefighting nozzles have fixed-gallonage combination fog and smooth-bore nozzles. For interior fire suppression, personnel should use a straight or solid fire stream. Though delivered from different nozzle styles, the straight stream and solid stream perform comparatively.

Fixed-Gallonage Combination Fog Nozzle

The fixed-gallonage combination fog nozzle is rated to deliver a specific amount of water at a specified nozzle pressure. Although traditionally operating at a nozzle pressure of 100 psi, most U.S. firefighting nozzle manufacturers provide options for lower nozzle pressures. Nozzle pressures of 50 or 75 psi occur often. The lower nozzle pressure facilitates lower pump discharge pressures and reduced nozzle reaction.

The fixed-gallonage combination fog nozzle provides a fog stream that personnel can adjust from a wide-fog to a straight-stream pattern. The wide-fog pattern expels tiny water droplets and entrains a significant amount of air. The tiny water droplets convert to steam with an expansion ratio of 1700:1 at 212 °F when introduced into a super-heated environment.

As they pertain to interior fire suppression efforts, the expulsion of tiny water droplets and entrainment of air represent largely negative effects, so members should avoid use of a wide fog pattern when conducting interior fire suppression efforts. Conversely, the straight stream, while still comprised of tiny water droplets, remains relatively intact during interior fire suppression and effectively cools surfaces and extinguishes fire. The straight stream entrains air, as do all fire streams; however, the air entrainment occurs at a volume comparable to solid streams.

In the event an engine company stretches short, many of these nozzles contain a breakaway tip that allows members to extend a charged hoseline from the threads of the nozzle's shut-off. If extending a dry hoseline, engine company members should remove the entire nozzle assembly and extend directly from the hoseline. This method prevents members from having to manage the nozzle's bale where the extension occurs.

Smooth-Bore Nozzle

The smooth-bore nozzle delivers a solid stream of water from a fixed orifice. The rate of water delivery from the fixed orifice depends on the nozzle pressure. For handlines, 50 psi is generally utilized as the standard nozzle pressure. However, handline pressures of 40–60 psi provide adequate fire streams for interior fire suppression efforts.

For master-stream operations, 80 psi is generally utilized as the standard nozzle pressure. However, depending on the specifications of the master-stream device, members may use higher nozzle pressures to increase flow, reach, and penetration. John Freeman developed the following formula for determining flow from smooth-bore nozzles (where d = diameter and NP = nozzle pressure).

$$29.7 \times d^2 \times \sqrt{NP}$$

John Freeman also recommended that smooth-bore nozzle orifices not exceed half the diameter of the hose to which they are affixed. This helps water accelerate adequately when moving from the hose into the nozzle; it also helps the nozzle firefighter control the fire stream. Modern fire hose often carries a true internal diameter slightly larger than its labeled diameter, which allows tips such as the 15/16" to be affixed to 1 3/4" hose.

The smooth-bore nozzle delivers a solid stream of water comprised of larger water droplets than the straight-stream fog pattern. The larger water droplets effectively cool surfaces, as the fire stream remains intact and is applied directly to the burning materials. Also, widely dispersed tiny water droplets more efficiently cool gases. When opting to use the smooth-bore nozzle, firefighters most often cite its simplicity as the biggest factor in their decision. The nozzle has no moving parts for changing stream patterns. Operating the smooth-bore nozzle with the bale fully opened maximizes the nozzle's flow and reach.

If the nozzle firefighter aims to break up the stream, a half-bale position reduces flow and reach but increases the fire stream's width. The nozzle is comprised of a fixed-orifice tip threaded to a shut-off. As such, the smooth-bore nozzle passes debris contained in the water delivery system more effectively than other nozzles. As is the case with the fixed-gallonage combination fog nozzle, the smooth-bore tip can be removed from the nozzle's shut-off to allow dry or charged hoselines to be extended. If extending a dry hoseline, engine company members should remove the entire nozzle assembly and extend directly from the hoseline. This prevents members from having to manage the nozzle's bale where the extension occurs.

Nozzle Reaction

Nozzle reaction refers to the force produced at the nozzle and transmitted backward while flowing the fire stream. Nozzle reaction relates to two factors: nozzle pressure and flow. Consequently, increasing either increases the nozzle's reaction. The formulas for nozzle reaction are as follows (where Q = gpm):

- Combination fog: $.0505 \times Q \times \sqrt{NP}$
- Smooth bore: $1.57 \times d^2 \times NP$

In 1990, Paul Grimwood (retired, London Fire Brigade) completed a research project on nozzle reaction and the operational effect on firefighters. Grimwood concluded that the maximum nozzle reaction that advancing and operating firefighters could effectively handle was as follows:

- One firefighter: 60 lbf
- Two firefighters: 75 lbf
- Three firefighters: 95 lbf

Training and technique may vary these values; however, Grimwood's research serves as a point of reference for operating and advancing hoselines. Properly staffed hoselines, with members working in a coordinated fashion, provide a tactical advantage during interior fire suppression. The nozzle firefighter relies on the backup firefighter to absorb and manage the nozzle reaction. This allows the nozzle firefighter to focus their efforts on fire-stream application and extinguishment. Staffing, personnel, hoseline selection, and the fire building all influence how hoselines are staffed. Considering these factors, companies should ensure their operations remain flexible and adaptable to the conditions they encounter while performing interior fire suppression.

A *master stream* is any stream flowing 350 gpm or more. Typically, engine companies within the region have an apparatus-mounted master-stream device and a portable master-stream device (see Figure 21). Some apparatus specifications allow members to remove the apparatus-mounted master-stream device from the apparatus and use it as a portable master stream. Firefighters may employ master streams to slow an advanced fire condition, apply water while handlines are being positioned, or extinguish large volumes of fire.

Figure 21. Apparatus-mounted master-stream device.

The apparatus-mounted and portable master-stream devices have respective advantages and limitations (see Table 8). As such, personnel should consider which device will provide the biggest tactical advantage.

Table 8

Master-Stream Device Comparison

Apparatus mounted	Portable
Immediately placed in-service from a fixed position	Can be placed anywhere and moved, as needed
Useful at greater heights	Excellent at-grade water application
Wider range of flows and pressures	Flow and pressure limitations
Limited effectiveness on first-floor fires	Takes time to deploy and place in-service

Master-stream devices can be equipped with combination or smooth-bore nozzles. However, the smooth-bore nozzle has distinct advantages when used on a master-stream device. By design, the solid stream leaves the nozzle as a solid column of water. Conversely, the combination nozzle delivers a straight stream that forms after leaving the nozzle. As such, the stream is less intact and more susceptible to impact from wind and thermal columns.

For automatic combination nozzles, *NFPA 1964* allows a pressure variance of ±15 psi from their rated pressure. This variance creates obvious issues with flow and stream velocity. Due to this variance, personnel should consider avoiding automatic combination nozzles for master streams, particularly when combating large-volume fires. Increased fire-stream velocity helps lessen the negative impacts of wind and heat on all fire streams. It also causes the fire streams to hit harder and better distribute water. Stream velocity is determined with the following formula:

$$12.14 \text{ x } \sqrt{NP} = \text{ft/s}$$

Stream velocity relates directly to nozzle pressure, so increased nozzle pressure increases fire-stream velocity and nozzle reaction. Consult manufacturer's literature to determine the flow and pressure limitations for particular master-stream devices.

Fire-Stream Application

The nozzle firefighter has the awesome responsibility of applying fire streams to complete fire extinguishment. The nozzle firefighter's job involves far more consideration than simply opening and closing the bale of the nozzle. Fire extinguishment should occur in the most efficient and effective manner possible, and understanding fire-stream application will facilitate this.

The nozzle firefighter must understand where to apply the fire stream, when to apply the fire stream, and the desired effects of the fire stream. Previous generations of the fire service stressed the importance of opening the nozzle only in the presence of fire and refraining from applying water to smoke. However, this outdated practice unnecessarily places engine companies in a vulnerable position. Smoke amounts to unburned fuel and should be handled accordingly. When advancing engine companies encounter a significant smoke condition and heat, regardless of visible flame, they should apply a solid or straight stream to the area overhead and in front. This action will likely improve conditions or prevent a rapid fire event from overtaking the advancing engine company.

Flowing and moving hoselines provide a constant cooling effect around and ahead of the engine company. The shut-down-and-move, or hit-and-move, technique allows temperatures to rebound when the hoseline shuts down. If the nozzle firefighter opens the hoseline within 10–15 s, the temperature will not return to the levels present prior to suppression efforts.

The Fire Safety Research Institute's 2017 Underwriter's Laboratory (UL) project: Study of the Impact of Fire Attack Utilizing Interior and Exterior Fire Streams on Firefighter Safety and Occupant Survival provided scientific data on fire streams. Two main areas of this project focused on water mapping and air entrainment, dynamics which provide significant insight into fire-stream effectiveness.

Water mapping identifies where fire-stream water ends up after exiting the nozzle. The nozzle only effectively applies a fire stream in an area within the nozzle firefighter's line of sight. Simply put, fire streams cannot be effectively applied around corners or other turns. The fire stream will travel along the surface it strikes until it loses momentum or strikes another surface. Nozzle firefighters operating in a hallway can apply fire streams to the walls and ceiling to maximize the amount of water distributed along surfaces.

Additionally, if needed, the nozzle firefighter can apply the fire stream to the sides and top of a door frame to begin to get water into the fire compartment. A fire stream applied to the ceiling at a steep angle will distribute the water across the greatest area of ceiling. A fire stream applied at a steep angle, reduced to a shallow angle, and returned to a steep angle will provide the best water distribution in a room. The UL tests confirmed this to be consistent with interior and exterior streams. When applying fire streams from the exterior into a compartment without an intact ceiling, firefighters can apply the fire stream to the lintel over a window, distributing water into the compartment. Once the nozzle firefighter reaches the fire compartment, they should apply water directly to the fire and all six sides of the compartment.

All fire streams entrain air. The length, movement, and width of the stream influence how much air a fire stream entrains. The solid stream and straight stream had comparable results throughout the air entrainment experiments. The longer the fire stream, the more air it entrains. The nozzle firefighter should utilize the reach of fire streams while remaining aware of the effects of the stream's length.

Moving the fire stream also increases the amount of air it entrains. When applying water to a fire area with uninvolved areas downstream from the nozzle, the nozzle firefighter should operate the nozzle with minimal movement to lessen the likelihood of the fire stream moving products of combustion into uninvolved areas. Conversely, when applying water to a fire area with a vent downstream, the nozzle firefighter should consider moving the nozzle to increase air entrainment. The increased air entrainment created by moving a flowing nozzle can reverse the flow path and push the products of combustion out of the ventilation point.

Opening the pattern of a combination nozzle or utilizing a half-bale technique with a smooth-bore nozzle also increases air entrainment. In addition, the half-bale technique with a smooth-bore nozzle decreases the nozzle's flow. In general, firefighters should not use this technique during fire attack but reserve it for mopping up or ventilation.

Hydraulic ventilation refers to the process of removing smoke and heat from a structure's interior through fire-stream air entrainment (see Figure 22). This technique quickly improves conditions within the compartment and increases visibility to enable the engine company to improve their environment. The primary advantage of hydraulic ventilation is that the engine company can perform it quickly and simply from within the structure. However, this counts as ventilation and must be coordinated with other operating units.

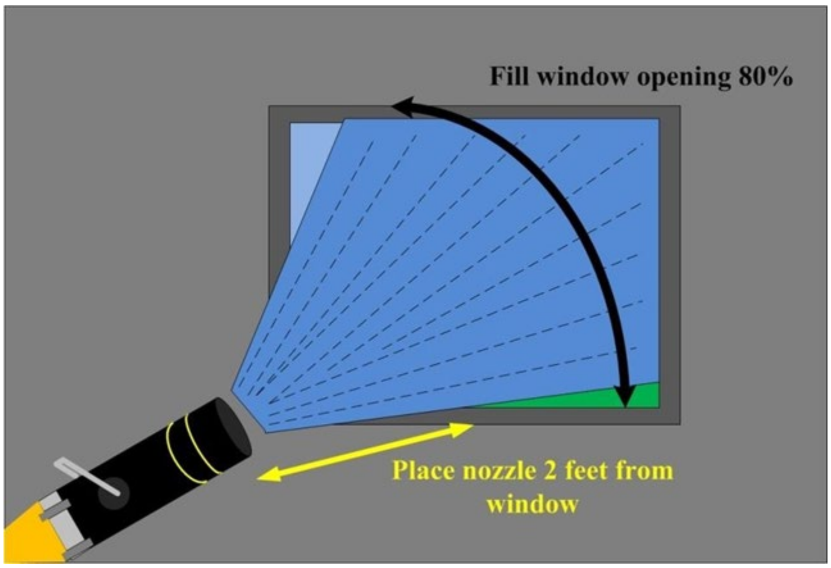

Figure 22. Hydraulic ventilation.

Hydraulic ventilation should take place as soon as possible after extinguishment. Traditional hydraulic ventilation practices have indicated the nozzle firefighter should place the nozzle 2 ft from the ventilation outlet, with a wide fog stream covering 80% of the ventilation opening. However, the UL fire-stream experiments showed that a narrow fog pattern, moved in an "O" pattern as far from the opening as possible, moves a comparable amount of air as positive pressure ventilation fans.

Cooling Gases

With no fire evident in the compartment, heat increasing to 800 °F or more at the ceiling level, and thick smoke banking down near the floor, interior crews must recognize the compartment is entering preflashover conditions. If a crew must continue operating in that compartment, they must consider changing compartment conditions or face the possibility of a forced withdrawal. This represents an ideal time to cool the gases. To interrupt these escalating conditions, firefighters should direct a stream at the ceiling and allow it to cool the gases.

Attack Methods

Pushing In

Pushing in occurs as the nozzle team begins their advance to the room of origin and they encounter fire in the compartment leading to the seat of the fire. The nozzle team should open the nozzle and apply water to all six sides of the compartment. At no time should a crew advance an unopened nozzle into a room before applying water to the fire. The fire attack must begin with the nozzle flowing water into the fire compartment while the crew advances forward through the doorway into the fire room. The hose stream should sweep the floor to prevent the hose from pulling across any material that could burn a hole through the hose, rendering it useless for fire attack.

Direct Attack

In a *direct attack*, personnel should apply a stream directly onto the burning materials until the fire darkens down. Interior firefighters use this attack method most often. Before advancing, firefighters should sweep the floor with the stream to cool embers and other hot material that could cause firefighter injury.

Indirect Attack

In an *indirect attack*, personnel direct the stream at the ceiling above the fire or the ceiling in the fire compartment. The ceiling will break the fire stream up into droplets, allowing steam conversion to displace the oxygen and absorb heat. This attack method is discouraged in areas where victims or personnel may be located due to the creation of steam in the compartment.

Combination Attack

A *combination attack* method utilizes both the direct and indirect methods at the same time.

Blitz Attack

Personnel use a *blitz attack* when they encounter a large volume of fire upon arrival. A blitz attack involves using an exterior master stream to knock down the main body of fire. Once darkened down, the engine company transitions to a handline for an interior offensive attack. The transition from a blitz attack on a structure's exterior to an interior offensive attack should be rapid and coordinated.

A successful blitz attack requires crews to be familiar with their master-stream devices. Knowledge of tip sizes and nozzle flow rates enables crews to estimate how much time they will have on tank water for the blitz attack. Crews must know the maximum, effective vertical and horizontal reach of their stream. This knowledge enables proper positioning to ensure personnel can reach the fire with an effective stream. Crews should also practice aiming at targets at various distances and heights to ensure accurate stream application. The stream should only flow long enough to darken down the fire so interior lines can advance.

ENGINE COMPANY OPERATIONAL ROLES AND RESPONSIBILITIES

This section describes the specific roles and responsibilities of each member assigned to the engine company.

Nozzle Firefighter Responsibilities

The nozzle firefighter is responsible for deploying hoseline from the apparatus and operating the nozzle. The nozzle firefighter should stretch hoselines methodically and in an expedient fashion to ensure they are in place quickly, taking a direct path from the engine to the entrance. The initial stretch by the nozzle firefighter must be well-organized to ensure the line will not kink or become hindered by obstacles. The backup firefighter should not have to completely reorganize the line.

The nozzle firefighter should maintain control of the shoulder load until the entrance is confirmed, as the location of the entrance could change at the officer's discretion. This order of operations prevents unnecessary confusion should the line need repositioning before advancing into the structure. This is also common practice when advancing into areas with a dry line. Once the location of entry has been confirmed, the nozzle firefighter should lay the shoulder load on the ground and don their face piece while the backup firefighter deploys and organizes the remaining hose. Within reason, the nozzle firefighter should be able to competently select handlines based on the distance of the stretch and the fire's size and location.

Backup Firefighter Responsibilities

The backup firefighter's responsibilities can range from hose handling to fire behavior observation and room control. Firefighting is a dynamic process that demands attention to detail and a level of proficiency in all personnel. To be proficient in this position, members should consider the following tasks and skills:

- Chase kinks.
- Eliminate excessive hose.
- Maintain correct position on the line.
- Observe conditions.
- Manage the room.

Chasing Kinks

Kinks are not an inherent characteristic of a hoseline; they become an issue when firefighters incorrectly deploy and advance a hoseline. Kinks must be eliminated to ensure accurate fire flow and advancement. The backup firefighter must ensure the entire hoseline is clear of the hose bed, evaluate the stretch, and isolate immediate kink potential.

Eliminating Excessive Hose

The backup firefighter must pay attention to the stretch and ensure the shoulder load is properly deployed at the point of entry. This ensures the line is ready to be charged prior to entry and eliminates the potential for excessive hose inside the structure.

Maintaining Correct Position

To maintain a correct body position, the backup firefighter should rest on one knee with their leading leg out front and their head up (see Figure 23). This position enables them to observe the conditions in front of them along with the hoseline movement. When the backup firefighter identifies a pinch point or turn, they must be on the outside of the turn or pinch point. This allows for rapid movement around the obstacle and deployment to the seat of the fire. The majority of hoseline movement occurs in the position occupied by the backup firefighter.

Figure 23. Correct body position: head up, leading leg out. The position on the left is the formerly taught, incorrect position; the position on the right is the preferred heads-up, low-profile position.

Maintaining a gloved hand on the hoseline provides the needed feedback to the backup firefighter. The backup firefighter can determine if a hoseline is advancing or flowing water. This can give the backup firefighter an indication of whether their position is good or if they should move up to assist with nozzle reaction. The backup firefighter must maintain discipline and move the line at the nozzle firefighter's pace to avoid pushing the nozzle from the nozzle firefighter's hands.

The backup firefighter should maintain an "S" formation in the hoseline. Once formed, the backup firefighter should constantly monitor and maintain the "S" until it is pulled straight. This indicates the hoseline is moving, and another "S" should be formed. If the "S" formation does not move and the backup firefighter can feel water flowing through the hoseline, this indicates the hoseline has made it to the seat of the fire, so the backup firefighter should advance up the line.

Observing Conditions

When the nozzle firefighter and officer make their attack and begin applying water to the seat of the fire, their visibility reduces to zero. This prohibits them from accurately assessing fire conditions. The backup firefighter is remote from the point of attack, which allows them to monitor fire conditions and relay pertinent information.

Room Management

The backup position is vitally important for successful engine company operations on the fireground. The backup position serves as the operation's backbone and often acts as the linchpin to successful hoseline deployment and movement. Successful hoseline management hinges on smooth hoseline operation to reach the seat of the fire. Many obstacles (e.g., walls, doors, furniture, and personnel) lay in the way of the advancing hoseline. The backup firefighter cannot control permanent fixtures; however, they can limit the number of personnel in the immediate area to facilitate smooth advancement.

Engine Company Driver Responsibilities

The engine company driver must familiarize themselves with their apparatus, equipment, hoseline lengths, and nozzles. They must know which nozzles and streams are in operation to deliver the correct flow of water to attack lines. Although the driver must multitask to accomplish specific objectives, the engine company driver's ultimate responsibility is the safe delivery of personnel to and from the scene. Drivers accomplish this by having a thorough understanding of their response areas, including second-, third-, and fourth-due areas.

When responding to a reported fire, the engine company driver must position the engine to create the most direct access for advancing attack hoselines to the seat of the fire while allowing the truck company to position directly in front of the structure. Often, this means positioning near the front of the structure, but certain circumstances may require the engine to position elsewhere, such as at the side of an end-of-row townhouse that has a Bravo-side main entrance. When spotting a hydrant, the engine company driver must consider how the positioning will affect later arriving units. Drivers must choose the appropriate intake that allows for a quick connection while leaving access for the remainder of the assignment.

Regardless of the layout, engine company drivers must all work together to effectively establish both the primary and secondary water supplies. To reduce radio traffic, engine company drivers can communicate face-to-face rather than over the tactical channel. The engine company driver must consider the size of the engine's booster tank when firefighting operations commence before a water supply has been established. When the tank level reaches half capacity, the driver must communicate this finding to the officer. This allows the officer to make a tactical decision on whether to maintain their position or consider a retreat until a water supply is established.

A water supply should be established before charging additional hoselines. However, firefighters must consider the reason for charging the hoseline. For example, hoselines for exposure protection, line to the attic, rapid intervention team (RIT) use, or controlling exterior fires may require charging a line before that water supply has been established.

The engine driver advises the requesting officer that no water supply has been established.

In addition to normal driver duties, engine company drivers should be prepared to perform nontraditional engine driver duties, such as placing portable ladders and advancing hoselines from the exterior of the structure. This usually occurs in jurisdictions with longer response times, where geographic location delays second due companies.

Engine Company Officer Responsibilities

The engine company officer acts as the quarterback for all incidents. Officers who are serious about training and expect a high level of professionalism from their personnel will see positive results reflected in their company's performance.

Radio Reports

The primary elements of communication relayed by the first-arriving engine officer pertain to water supply instructions, an on-scene report, a situation report, and a command statement. Personnel should reference the NOVA *Field Communications* manual for a detailed discussion of IC responsibilities and associated radio reports.

Size-Up

The initial actions of the first engine will typically determine the success or failure of the entire incident. The engine officer should communicate the action plan based on information gathered during size-up.

During size-up engine officers should determine:

- the lowest level of fire involvement,
- the presence of and access to the basement,
- the number of floors and how they will be labeled,
- the potential for fire extension,
- the location of egress from the structure,
- the initial operational mode,
- the fire's flow path and what effect tactics will have,
- the most appropriate position to deploy the first hoseline, and
- the most appropriate position to deploy the second hoseline.

Although using RECEO VS is appropriate, the engine officer must make tactical decisions based on what actions will most quickly and safely mitigate the incident. For example, the best course of action may be to extinguish the fire prior to making a rescue; the situation may call for incoming units to take their assigned positions per NOVA operational guidelines, or the engine officer may need to deviate from the guidelines to make assignments that address immediate incident needs.

Incident Command

The first due engine company officer serves as the IC by default until Command can be formally established. After the engine officer has completed the size-up and determined what actions must be taken, they must make a command statement. The engine officer has two options:

- Request to transfer Command: The first due engine company officer considers this when the incident requires immediate interior operations. This is the most common practice. It allows for the responding battalion chief to assign Command to a later arriving unit or establish Command upon their arrival.
- Establish Command: The first due engine company officer considers this when the incident requires initial units to take an exterior or defensive position due to fire involvement. Remaining on the exterior allows for proper accountability of their engine company while tracking other responding resources in a tactical position.

Company Operations

The engine officer should ensure the nozzle firefighter stretches the appropriate hoseline for the incident based on flow and length. The line placement should be based on information gathered during the size-up. The overriding objective is to advance to the seat of the fire as quickly and safely as possible.

If the engine officer finds the entrance door to the structure or immediate fire area open, they should close it to control the flow path. Door control represents a critical aspect of all firefighters' safety and should be performed while members don their PPE prior to entry. Controlling the door discontinues the introduction of oxygen into the fire compartment and can prevent conditions from worsening. Prior to entry, the officer must ensure their company is wearing all appropriate PPE and the hoseline is charged with adequate pressure and flow. If the company is stretching dry to a protected area, the engine officer should communicate this to the engine driver.

Before advancing into the IDLH with the hoseline, the engine officer should relay to the nozzle team information gathered while the line was being stretched. This information might include the location of the fire or the path they will travel to approach the fire. Conditions will dictate the firefighters' position upon entry (i.e., "if you can't see your feet, you shouldn't be on them"). Staying low allows firefighters to remain in less heat, take advantage of better visibility, and provide better positioning in the event of a sudden change of conditions.

During hoseline advancement, the engine officer must constantly monitor the nozzle team's progress and the conditions around them. The protection afforded by PPE insulates firefighters from the hostile fire environment, which could cause members to penetrate unknowingly into severe conditions. As the hoseline advances into the fire area, the engine officer should communicate orders and directions to the nozzle team using as few words as possible. The engine officer can encourage the nozzle team with statements such as "you got it," "move in," and "good knockdown."

When supervising the nozzle team, the engine company officer's position must remain fluid. When the hoseline advances into tight quarters and the nozzle team is forced to make turns and bends, the officer may have to drop back on the line, switch sides, or even move ahead of the nozzle momentarily to facilitate optimum nozzle positioning.

Crew Communications

Officer should determine crew communication methods prior to incident response through company training. The terminology used while operating on a hoseline must be consistent across the entire company to maintain clarity and conciseness. Effective communication between an officer and their crew is paramount to the safety of the entire engine company. The company officer takes responsibility for crew accountability and safety, but each member must also communicate to maintain accountability and situational awareness.

During the fire attack, the noise created by the hose stream makes communication difficult. However, the engine officer must monitor the radio for critical information that may affect progress. This includes ventilation delays, water supply difficulties, collapse potential, a Mayday, or urgent transmissions. Firefighters often maintain a low portable radio volume to minimize potential feedback when their officers are transmitting radio messages. Consequently, officers should relay critical radio transmissions to their firefighters to ensure the crew maintains situational awareness.

Although the nozzle firefighter has some decision-making authority, they must understand that their actions fall under the strict supervision of the officer commanding the hoseline. The officer must exercise the power of command under fire attack conditions and receive prompt response and action from their crew. Establishing company level operational expectations and responsibilities during training events, prior to incident response, increases the efficiency and success of fireground operations.

Personnel should be prepared to carry out the following tactics at the direction of the engine officer:

- charging the line,
- opening the nozzle,
- advancing the line,
- stopping line advancement,
- initiating fire attack,

- shutting down the stream, and
- using stream for venting,

Decisions that may be delegated by the engine officer to the nozzle team include:

- determining stream direction,
- determining rate of advancement,
- opening nozzle in an emergency,
- partially shutting down nozzle to reduce nozzle reaction and regain control,
- calling for more line, and
- sweeping floors with stream.

CAN Reports

During the fire attack, officers should provide the IC with vital information related to their crew's strategic progress and tactical needs. This information is communicated through a CAN report. These reports should focus on critical information and be as concise as possible. When delivering CAN reports, officers should transmit messages such as the following:

- "Battalion 401 from Engine 425. [Conditions] On the first floor we have considerable heat & smoke conditions with a fire in the kitchen area. [Actions] Engine 425 has a line on the fire. [Needs] requesting horizontal ventilation on the first floor and check for extension on the second floor."
- "Battalion 401 from Engine 425. We have the fire knocked down, checking for extension."
- "Battalion 401 from Engine 425. We have a fire in the attic. We need a second line to our location."

Personnel should reference the NOVA *Field Communications* manual for a detailed discussion of CAN reports.

After Extinguishment

After personnel have extinguished the main body of fire, the engine officer should order the nozzle to shut down. This action allows heat and smoke to rise and any remaining fire to light up to indicate those areas requiring follow-up extinguishment. The officer can then check adjoining spaces (e.g., opening walls and ceilings) for fire extension.

The level of physical activity required for firefighting has been well documented, so company officers must recognize the debilitating effects on personnel. The engine company officer should evaluate the members of their unit during and after the fire attack and promptly request relief for the entire unit when individual members require it.

Other Considerations

Searching With a Hoseline

When performing a primary search, firefighters encounter ever-changing conditions that can rapidly deteriorate. Hoselines can protect crews assigned to the primary and secondary searches, enabling them to effectively search under more tenable conditions.

Thermal Imager

The thermal imaging camera provides a valuable tool that saves victims' lives by enabling firefighters to see victims and their crew in zero-visibility conditions. The officer can position at a point of reference and maintain crew accountability while monitoring conditions within the structure. However, the thermal imaging camera should not serve as the sole source of vision while navigating through a structure.

ENGINE COMPANY OPERATIONS

Incident Response

After being dispatched and responding to an emergency incident, firefighters should determine the type of emergency they will encounter, identify the incident location, and anticipate the responsibilities associated with their unit's arrival order.

To mitigate any emergency, firefighters must arrive safely at the incident scene. Apparatus response should follow each jurisdiction's respective procedures. Firefighters can shorten response times by quickly turning out for responses, not by reckless driving. Accidents delay or prevent personnel from aiding those in need and often result in civilian and firefighter injuries.

To eliminate complacent behaviors, personnel responding to fire alarms should prepare as if responding to a confirmed building fire.

Engine company officers should identify a water supply and prepare to lay out if needed. When responding with a truck or rescue company, the engine company may choose to stage at the water supply and allow the special service unit to investigate.

If an engine company responds alone or arrives significantly before a truck or rescue company, officers should consider having one firefighter remain with the engine driver to facilitate water supply operations and deploy the initial hoseline if needed.

If the building is standpipe equipped, the engine driver should remain with the vehicle while all other engine company personnel enter the building to investigate. Personnel should don appropriate PPE, including SCBA, before entering the building and equip themselves with hose packs and other tools associated with their riding position.

Before entering the building, personnel should obtain Knox box keys, if present, for access to remote areas. Personnel should check the fire alarm or annunciator panel and verify the location, type, and number of alarms activated. While investigating, personnel should gather information from occupants or building representatives regarding the exact location and nature of the alarm.

Arrival Order and Responsibilities

Specific engine company responsibilities and associated tactics depend on incident-scene arrival order. Engine companies must take their predetermined assignments based on their position in the dispatched run order. Arrival based engine company responsibilities are discussed in detail within NOVA occupancy specific manuals.

When an engine company is available near a dispatched call with multiple units already responding, the unit officer should consider the complications caused by altering response order responsibilities and the associated incident communication effects of adding to the incident. Company officers should refer to the latest edition of the NOVA *Field Communications* manual for information related to the standardized process of adding to incidents and the associated considerations.

First Due Engine Company

The first due engine company's typical responsibilities are as follows:

- View as much of the structure as possible during approach.
- Communicate primary water supply report to the second due engine.
- Position to allow for rapid advancement of hoselines while maintaining priority positioning for truck companies.
- Communicate an on-scene report to the first due command-level officer.
- Perform a 360-degree lap of the structure.
- Communicate a situation report and command statement to the first due command-level officer.
- Deploy the initial hoseline and begin fire suppression operations in coordination with Command.

The first engine and all other engine companies should be prepared to forcibly enter if they arrive significantly before the first-arriving truck or rescue companies.

Second Due Engine Company

The second due engine company's typical responsibilities are as follows:

- Ensure primary water supply to the first due engine is established.
- If the first-due engine has established water supply, position so as not to impede other responding units.
- Assist the first engine with initial hoseline, if needed.
- Prepare to deploy a second hoseline.

Third Due Engine Company

The third due engine company's typical responsibilities are as follows:

- Establish a secondary water supply; coordinate with the fourth due engine if needed.
- Position to allow for rapid advancement of hoselines to the side of the structure opposite the initial hoseline, typically side Charlie (i.e., rear).
- Communicate to Command the conditions found on the side of the structure opposite the initial hoseline. Report should include
  - evident conditions;
  - the location, volume, and characteristics of any fire or smoke; and
  - the presence of any persons in distress.
- Deploy a third hoseline and begin fire suppression operations in coordination with Command.

Fourth Due Engine Company

The fourth due engine company's typical responsibilities are as follows:

- Ensure a secondary water supply is established.
- Establish an initial RIT.

Personnel should reference the NOVA *Rapid Intervention Team Command and Operational Procedures* manual for information about initial RIT responsibilities and operations.

Fifth Due Engine Company

Incidents involving mid- or high-rise buildings, buildings associated with the Washington Metropolitan Area Transit Authority (i.e., Metro), and data centers require the response of a fifth due engine. Responsibilities and actions for this engine vary depending on the type of structure. Refer to the appropriate manuals for those responsibilities and actions.