Tactical Implications of Bold Risk Management in the Fire Service: Realities of Combat Ineffectiveness in the Risk Adverse Culture

Approved by Dr. BJ Reed

for BJ Reed
The hallmark of a good fire department is an aggressive and thorough search. Most fire departments have somewhere in their mission statement the tenant to save life and property. In reality saving life is really what we are here for. The public likes all the neat stuff we do but when push comes to shove they want us around to save them and their loved ones from doom. Although they may not consciously think about it, people in your community go to sleep at night with the comfort that some unknown man or woman will come to their home and rescue them in the night from the horror of burning to death.

(Bircault, 2010, p.1)

Commissioner Mike Lombardo, Buffalo, NY, Fire Department

Figure 1: Photo of St Paul Firefighter Ed Rylicki saving a girl from a structure fire and providing mouth to mouth resuscitation. The girl later survived. The photo won an IAFF award for the firefighter who took it. Retrieval from Fire Service Messages get free Billboard Space, by F.Oberg, 1978, Fire Engineering as found on web at: https://www.fireengineering.com/articles/print/volume-131/issue-4/features/fire-service-messages-get-free-billboard-space.html)
Do You Believe all Fire Departments Place Your Rescue as their Commanding Faculty?

The American Fire Service has long been the pride of civilization. A very strong sense of honor, integrity and service are derived from its members. The quote heading this paper is a fire service proverb which speaks to the passionate members who follow its luminaries. A more timeless and common quote from the Bible guides humanity: “Greater love has no one than this: to lay down one’s life for one’s friends (John 15:13).” The very notion of this sacrifice speaks to civilization and is entwined in the fire service precepts. The American public believes that firefighters will place themselves in harm’s way to rescue them and their families from the perils of fire. This belief and need create the maxim which is the basis of this research paper. Delaying aggressive search and ventilation tactics jeopardizes the fire service mission. Aggressiveness is a firefighting maxim this paper defines through bold search and ventilation tactics.

In the span of ten years from 2008-2017 nearly 32,000 people died from fire events, the same time span shows an annual average of 16,219 civilians injured from the effects of fire (U.S. Fire Statistics, 2019). The need for the fire service to respond in a fashion to reduce or minimize these losses is axiomatic. Victims whose welfare is being attacked by the products of fire have a specific need: a reduction to exposure.

The exposure most prevalent at structure fires is the super-heated and toxic gases within the smoke filling the structure. Smoke inhalation is often the primary cause of death or injury to those who endure such an incident. Thermal exposure is of concern as well as the other hazards created by structure fires, but smoke inhalation is of primary concern (Zevotek, Stakes, & Willi, 2018)
Based on conditions the tenability of a structure fire to sustain human life is often reduced to minutes. Fire spreads through atmosphere movement and oxygen consumption. The environment sustaining life is weeded out through fire propagation and replaced by an inferno of heat and toxicity. The only hope for an overcome victim laying in the path of combustion is the prompt intervention of fire combatants.

The need for prompt intervention is clear. The fire service has many different models of staffing, response, equipment and tactics throughout the nation to address this need. Circumstance is often a factor influencing the differences of these departments. Yet certain tactics remain necessary for the removal of victims from structure fires. Time is of primary concern.

How a department prioritizes and executes its tactics has significant influence on its ability to alleviate a victim from the fire’s deadly effects. Violence of action is the calling card to aggressive firefighting and raises the flag of efficacy in fire combat. Violence of action is a term utilized in military training to indicate a posture of decisive movement throughout the threat zone, the impetus is to make timely decisions in a forward advancing, ground taking endeavor. Courtley (2015) uses this definition in his text Navy Seal Survival Guide “Violence of action means the unrestricted use of speed, strength, surprise, and aggression to achieve total dominance against your enemy (p.15).” The impact tactics whose implementation open the window of survivability are suppression, ventilation, and search.

Suppression (the work of the Engine Company) is the most focused tactic in the American Fire Service. Search and Ventilation are associated with Truck Company functions. The Truck Company functions, and their deployment have been lost in fire combat across
America (Mittendorf, 2011). The negligence of these vital functions as a staple of fire combat has greatly reduced the efficacy of the American Fire Service (Fried, 1972, p.22).

Often municipalities’ demographics do not have a need for aerial apparatus. The department is thus unable to obtain funding for the expensive apparatus. The delineation between Engine work and Truck work is now abstract without the very piece of apparatus which carries the combatants whose detail is attacking the building while those on the handlines attack the fire.

The oversight here is a very important one, noted later in this paper seven of ten defined aggressive tasks are Truck-Company oriented. An organization whose fire ground behavior is aggressive is by nature Truck Oriented. Described here is another factor which inhibits aggression on the fire ground, only deploying Engines to fire grounds tends to create an Engine-Oriented fire service in its attack posture.

As a profession the fire service often finds itself questioning old tactics at the expense of new findings. Throughout history, humankind has sought progress and improvement in all facets of life. The fire service is no different. The members making up its organizations seek best practices for the sustainment of their purposes. The reality in the fire service though, has also shown a decrease in fire events, civilian fire fatalities, and an increase in mission scope (Ahrens, 2017). The service is now an all hazards response agency tending to technical rescue events which include high angle rescue, confined space, structural collapse as well as terrorist type activities. Furthermore, the growing demand of emergency medical response has consumed the day-to-day operations of a service whose main duty was fire attack at one point in time.

Theoretical basis of job performance has swayed leaders’ opinions on how to manage victim needs (B. Pressler, personal communication, July 9,2019).
Recent scientific research where variables are controlled have led to tactical debate in the fire service serving to further hamper truck company initiatives (Governors Island, 2013). The Governor Island Experiments placed priorities on exterior water introduction prior to entry into the structure at fires with the impetus being on creating safety for victims and firefighters alike by reducing temperatures throughout the structure. The studies also redefined the air track of a fire using the terminology of flow path. Criticizing ventilation tactics and interior attack with these flow path findings has created much debate on ventilation operations and firefighter entry into the structure during the early phases of fire combat.

The early phases are the most critical to ensure a survival window for fire victims. Vertical ventilation has also been waning in deployment due to the relative risk associated with its use (Appendix K & G). Working above the fire on a peaked roof is a challenging undertaking to be sure; where firefighters are exposed to the vertical exposure coupled with working above fire.

Immediate search of a structure is an impact tactic which enables rescue. Search has also been interpreted by risk adverse sects of our industry at the expense of its effectiveness. OSHA (n.d.) standards of “2 in - 2 out” and firefighters remaining in direct contact on the interior of a structure, while searching, have led to misinterpretation by fire service leaders and instructors (NFPA, 2016). These misguided search tactics introduce timid implementation of a vital tactic. The timid posture reduces search focus and increases time before locating victims. Reluctant execution of search is a moral failing of the fire service mission.

The omission of these tactics or delayed execution is not without reason. Often leaders will cite the need to protect firefighters in combat. Working inside a structure fire without a line is precarious business. Having firefighters lost in the structure, cut off from egress, or overcome
by heat are real concerns. Firefighters have died and been injured carrying out aggressive search and ventilation tactics. However, this paper will quantify how often that is the case. Furthermore, the paper will quantify which tactics are having a true impact on the life safety of our victims so that a practical risk / benefit analysis maybe conducted. Risk management is the vocation of the fire service, the aim of this research is to guide the fire service in fulfilling its core duty.

**What Factors Influence Victim Survivability at a Typical Structure Fire?**

A clear understanding of the impact a structure fire has on potential victims will require a few different measurements and definitions associated with the fire environment. An understanding of the hazards associated with fire and its by-products, as well as the effects it has on potential victims is required to conduct thorough analysis of risk. Equally important to understand is duration of exposure to hazards associated with the fire environment. The duration a victim may be exposed to a fire relates to the timing of fire department response, it’s tactical engagement and accumulates to a successful removal of the victim from the environment. Quantifying these variables enables proper judgements regarding tactical engagement associated with the risks and outcomes.

Victims trapped in structure fires are exposed to several potential hazards depending on the circumstances of the event. The most prevalent hazards commonly induced by fire scenes are thermal injury and smoke inhalation. This paper does not look to delve into the content of smoke products as research has already been conducted to qualify the toxicity of smoke. Research indicates that duration and dose of exposure to thermal insult as well as smoke inhalation accumulate to effective injury, refer to images in Appendixes A and B.

The calculations in this portion of the paper will focus on studies conducted by Underwriters Laboratories Safety Research Institute. The study referenced is: “Impact of Fire
Attack Utilizing Interior and Exterior Streams on Firefighter Safety and Occupant Survival: Full Scale Experiments.”

The UL report on victim survivability was released in January 2018. The document clearly defines the hazards fire victims experience with data from the USFA: “Burns and smoke inhalation combined were the primary symptoms for 48 percent of the fatalities of residential fires. Smoke inhalation alone accounted for an additional 37 percent of residential fire fatalities, and thermal burns alone accounted for only 6 percent of fatalities (Zevotek, Stakes, & Willi, 2018, p.88).” Smoke inhalation is a primary factor with deadly influence on 85 percent of victims. Ventilation thus becomes an intervention associated with life sustainment on these terms.

Quantifying survivability in fire exposure is a dynamic process with variables relating to contents on fire, victim location in structure and several others. However, the above-mentioned study utilizes a baseline of “fractional effective dose” (FED) to illustrate how much exposure to heat and smoke would constitute death. The FED is a measurement of exposure to heat energy in time exposed as well as dose of carbon monoxide concentration which would incapacitate 50 percent of the population exposed. Basically, the higher the FED the less chance of survival with a value of 1 constituting an exposure ending in death for 50 percent of the population. Exposure effects will differ based on age, gender, and other variables. Table 1, below shows time to reaching fatal FED, based on fires in various parts of the structure and victim locations.
Ultimately the studies reveal that victims closest to the room of origin relating to the fire and above the fire are most severely impacted by this exposure. Thermal energy radiates and smoke rises through convective currents creating hazards in multiple locations throughout a structure.

One article in a fire engineering magazine set to determine at what point did a structure fire become deadly. The consensus was the fire became deadly once it reached flashover. Flashover is a fire behavior phenomenon occurring when all contents in a room reach combustion temperatures. The article further states the deadly effects of flashover regarding heat radiation, smoke production and further development of the rest of the house (Waters, 1999). The article displays various times in which fires reach flashover. The times a given fire reaches this stage of development vary based on materials burning, available oxygen and space involved. A fair estimate concludes that flashover can be reached within a room as early as 2-4 minutes post ignition (Waters). Recent research by UL has furthered this with lab testing findings that modern

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Victim</th>
<th>Time to Fatal FED (minutes:seconds)</th>
<th>Driving Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment 1</td>
<td>Victim 1</td>
<td>8:10</td>
<td>Toxic Gases</td>
</tr>
<tr>
<td></td>
<td>Victim 3</td>
<td>6:58</td>
<td>Toxic Gases</td>
</tr>
<tr>
<td>Experiment 12</td>
<td>Victim 1</td>
<td>6:30</td>
<td>Toxic Gases</td>
</tr>
<tr>
<td></td>
<td>Victim 3</td>
<td>5:14</td>
<td>Toxic Gases</td>
</tr>
<tr>
<td>Experiment 17</td>
<td>Victim 1</td>
<td>3:08</td>
<td>Total Flux</td>
</tr>
<tr>
<td></td>
<td>Victim 3</td>
<td>3:06</td>
<td>Toxic Gases</td>
</tr>
</tbody>
</table>

Table 1: Time to LC50 FED (Minutes) – Delayed Intervention. Table provided by Zevotek, Stakes and Willi, Impact of Fire Attack Utilizing Interior and Exterior Streams on Firefighter Safety and Occupant Survival: Full Scale Experiments (2018) p. 98. The table indicates the time it took for victims in the live fire experiments to reach the LC50 of exposure to heat and toxic gases. Victims were in various positions related to the fire. LC 50 was considered the baseline for death in most individuals.
fuel loads coupled with modern construction designs are showing quicker propagation of flashover. Their experiments compare legacy (furnishing / homes of the past) flashover times with modern and can be seen in the following table.

<table>
<thead>
<tr>
<th>EXPERIMENTS</th>
<th>MODERN</th>
<th>LEGACY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,2</td>
<td>3:40</td>
<td>29:30</td>
</tr>
<tr>
<td>3,4</td>
<td>4:45</td>
<td>3:15</td>
</tr>
<tr>
<td>5,6</td>
<td>3:20</td>
<td>Not Achieved</td>
</tr>
</tbody>
</table>


Further consideration of the deadly effects of the flashover phenomenon has us consider not just the thermal issue, but victim tenability from a respiratory stance. UL Safety Research has been adamant to point out that fires will reach a vent limited state within minutes should no ventilation openings exist in a structure (Governors Island Experiments, 2013). Should flashover not exist due to this vent-limited state, victim tenability is still in peril from the respiratory exposure to the toxic products of super-heated smoke. As seen in this graph from a UL report.
The graph shows oxygen percent below ten within five minutes post ignition. Human life requires 16 percent oxygen prior to becoming oxygen deficient, much the same as fire (Clark, 1991). A logical discussion centers on the fact that regardless of the fire condition reaching flashover or a vent limited state victim tenability is in question. The following table (picture 1) shows the effects of hypoxia on humans.

Graph 1: Displays oxygen percentage during live fire testing coupled with fire progression, temperatures, and time frames within modern or legacy residential structures. Graph by Kerber, S., & Pravinray, G. (2013). UL Research with Firefighters to Adapt to Changes in Home Fire Severity(p. 23, Rep.). Holbrook, IL: Underwriters Laboratories.
The fact remains that a victim’s exposure to a structure fire is an immediate attack on their life; that attack includes accumulative effect, which will result in death rapidly. The duration a victim is exposed to these fire-related elements has a direct impact on their survivability, thus becoming a critical factor of consideration for the fire service whose mission is to effect rescues in this theater of combat. Search and Rescue tactics deployed instantly by the fire service become a necessary influence on an effective fire ground.

Whether through thermal insult or respiratory distress victims have less than ten minutes of exposure to its deadly effects to survive. Further research supports this time frame. A voluntary independent firefighter rescue survey indicate that sixty four percent of rescues made in four minutes or less of exposure to the environment ended in victim survival (Firefighter Rescue Survey Data). However, the same survey shows that only 19 percent of victims found after the six-minute benchmark survived the fire event. The data indicates the survival window

**Table 1. Effects of Hypoxia\(^8\) (Reduced Oxygen)**

<table>
<thead>
<tr>
<th>Oxygen Percentage Available</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Normal conditions, no effect.</td>
</tr>
<tr>
<td>19.5</td>
<td>OSHA oxygen-deficient atmosphere.</td>
</tr>
<tr>
<td>17</td>
<td>Muscular impairment, rapid breaths.</td>
</tr>
<tr>
<td>12</td>
<td>Dizziness, headache, rapid fatigue.</td>
</tr>
<tr>
<td>9</td>
<td>Unconsciousness.</td>
</tr>
<tr>
<td>7 to 6</td>
<td>Death within a few minutes.</td>
</tr>
</tbody>
</table>

for victims in a structure fire to be within six minutes post fire department arrival. The 10-minute mark appears to be a point where little can be anticipated regarding a viable rescue. The survey indicates 96 percent of victims who survived structure fires were rescued within the first ten minutes of fire department arrival. Clearly the first six minutes of arrival present the biggest window of opportunity in securing life. The evidence from previous studies and these rescue surveys appears to indicate that heat and smoke are the most insidious weapons the fire deploys on its victims. Time is the most critical factor to those being exposed to such environments.

**What Tactics does the Fire Service Deploy to Rescue Fire Victims?**

The discussion regarding deployment tactics centers on a sound understanding of the problems each firefighter faces in the combat theater heat, smoke, and structural compromise. A component influencing the safety of the fire service also at play is the arousal each fire service member feels during the stress of combat. Limited decision-making time, availability of resources, and an intense physical demand together increases risk.

The physicality of firefighting is significant. Each firefighter is outfitted with over 50 pounds of gear just to protect against the products of combustion (Picture 2). The fire member then deploys tools, often 10 pounds or more each and drags hose lines with hundreds of pounds of water weight held within it. The removal of victims becomes a desperate and arduous task. The dragging of a limp, heavy body or carrying a victim down a ladder strains even the hardiest firefighter. Hasty judgements under intense physical duress, lacking preconditioned responses influence the safety factor for firefighters in such a plight.
Addressing exposures to these hazards are the compelling drive of the vigilant servant in the arena. Exposures to fire presents in three main forms. Life exposures, interior exposures and exterior exposures. Life exposures consist of the victims whose survival is under attack from the

*Picture 2: Firefighter gear layouts and weight based on function. Firefighters carry several tools wearing insulated protective gear while doing strenuous work. Picture retrieved from: https://www.safirefighters.com/?zone=/unionactive/view_article.cfm&HomeID=678251&page=News*
products of combustion. Interior exposures include any rooms within the structure on fire in which
the fire is spreading towards. Exterior exposures are the buildings located next to the structure
involved (Fried, 1972, p.37). The focus of this paper intends to address the life exposure produced
by fires effect and the tactics which alleviate a victim’s condition.

The typical fire department in America suppresses fire by delivering water on the seat of
the fire, which supports the primary search effort. The fire service deploys hoses called “hand
lines” to locations enabling fire suppression. In many situations this is most effectively
accomplished from an interior posture (Braidwood, 2016). Moving handlines to the interior
position effects complete extinguishment while also confining the fire to the point of origin. A
hand line or stream placed between the fire and victims positively influences the welfare of
victims, interior exposures and the firefighters conducting aggressive searches (Fried, 1972,
p.37).

The fire service has tactical priorities to ensure a logical rhythm of deploying its
resources based on priority. The mnemonic RECEO – VS was developed by the late Lloyd
Layman to address this issue (Layman, 1940).

1. Rescue
2. Exposures
3. Confinement
4. Extinguishment
5. Overhaul
6. Ventilation
7. Salvage
The first handline deployed on a fire ground is called a *primary attack line*. The fire service deploys secondary hand lines often called *back-up lines*. The purpose of the secondary line is to protect the integrity of the first line. The secondary line can also be deployed to exposure areas of the fire when the primary line proves to be effective. Extending fire that is not addressed increases everyone’s exposure to fires hazards Often a misinterpretation of this back-up line is to keep it in a stationary position behind the primary line or to staff a back-up line prior to search. Any misuse of resources in the critical moments of attack have dire repercussions for those life exposures in need of relief. Failure to address the life exposure in the survival window induces combat ineffectiveness. Delaying rescue opportunities endangers the fire departments noble purpose and negatively impacts the survival window.

A short note on methods of attack within the fire service is included in this paragraph. *Interior attack* is an aggressive enterprising mode which has handlines moving to address interior positions protecting life and interior exposures. This method of attack is referred to as “Offensive Fire Attack”. *Exterior attack* is generally deployed when the fire situation is robust to the degree where the heat and volume become untenable for the highly protected firefighters and threaten to involve exterior exposures. Generally, these situations utilize large caliber streams with intention at protecting exterior exposures. This method of attack is referred to as “Defensive Fire Attack”.

This paper does not look to address defensive fire attack; such attacks write off the survival of any occupants within the structure. “Transitional Attack” is a situation where stream engagement is conducted from the exterior of the structure through a window or doorway. Opportunities to confine the fire, rescue victims, and enable complete extinguishment can be limited with the deployment of this tactic (Braidwood, 2016).
Water supply is a primary concern of the fire service. Many fire department engines arrive with a limited-on board supply to start fire attack. Judgement of how much fire can be extinguished with this supply is reserved for the officer in command of his fighting unit. Fire engines typically hold 500, 750, or 1000 gallons of water to initiate the attack. Water and its application thus become a paradigm of exposure time, the volume of fire and resources allocated to resupply the fire engine. Ensuing tactics to address this concern are handled by later arriving engine companies who connect to hydrants and deploy large diameter hose lines.

However, many departments look to address a portion of both tactics on the arrival of the first arriving engine. The “forward lay” is a tactic where the first due engine lays a large diameter line from the hydrant to the fire building. The tactic slows advance to the structure in stopping at a hydrant, having a member go to the rear of the rig, grab the supply line and wrap it around the hydrant. The member then re embarks on the engine and the crew heads to the structure while line is laid off the rear of the rig.

This tactic does ensure an expedited water supply, but it comes at the expense of the victim who is exposed to the elements. The forward lay delays fire attack by at least 30 seconds from the slowing down of rig advancement coming to a stop and starting back up to the structure coupled with the member movement off the rig to the hydrant and back on the rig. The purpose of an on-board water supply is to expedite the attack for the entrapped citizen.

Water supply can be handled in another manner via the booster back up. This practice cited by Battalion Chief Curt Isaacson utilizes the next arriving engines on-board supply to supplement the first due engines attack (As found at: https://countyfiretactics.com/2018/11/10/booster-back-up-3rd-due-for-supply/).
Basically, this tactic continues to buy time for the first company, while also deploying more firefighters to aggressive operations close to the scene. The tactic does not address the eventual need of a continuous water supply, but it does optimize the early resources and need for the aggressive attack.

Another operation which can increase efficiency of water supply is the “flying lay” of large diameter supply line (Fornell, 1991). Situations where the hydrant is close to the first due engine, the driver of this rig can stretch this line on foot by pulling it to the hydrant. Efficiency is high in this method as one person handles this objective, freeing the next engine company for other aggressive operations.

“Reverse lays” are common in the fire service where a later arriving engine drops personnel near the first due rig. Members pull a large diameter hose off the rear of this rig to the primary attack rig. Once this is completed the driver of the later arriving engine drives to the hydrant while line is deployed. This tactic places the secondary company at the structure while teaming up the first two drivers to establish the supply. The firefighters and company officers embark on aggressive opportunities.

Search operations lead to rescue opportunities. Search should be deployed in conjunction with or before suppression when possible. Suppression is aimed to support the search. The search supports the primary mission of the fire department. There are two types of searches commonly deployed by the fire service: the primary and secondary search. The primary search is a focus in this paper for it is responsible for the rescue of most occupants (See Graph 3). The primary search is responsible for locating nearly 60 percent of victims in comparison to other tasks conducted on the fire ground. The fire attack assignment is responsible for finding 26 percent of victims in the survey. Sixty three percent of victims found by the primary search had survived.
A rescue is defined as the removal of a victim with a pulse at the time of the event. The next most prevalent fire ground assignment responsible for rescuing victims is that of fire attack, whose success rate in rescues is 48 percent. The primary search is a hasty recon of the interior exposures where victims may be located.

A secondary search is a slower more methodical recon when conditions have stabilized and readdresses areas already covered by the primary search effort. The secondary search realistically is a recovery effort (Coleman, 2011). Victims exposed to elements for the time it takes to complete both searches are rarely found alive. Secondary searches recorded in the rescue survey data indicate that 75 percent of victims found during this operation are deceased (Firefighter Rescue Survey Data). This fact points to the critical nature of the primary search.

Primary search is conducted in three various modes throughout the fire service. These modes are described by Bob Pressler in his FDTN Article “Aggressive Search” (Pressler, 2002). The three modes are aggressive, active, and passive. The article depicts the posture of each search in relation to the timing of the event and conditions met upon deployment.

Passive search is done in a manner when little relative risk is present due to the late nature of its deployment. Passive search is a less opportunistic method once the scene has been stabilized. The fire problem has been addressed, fire is extinguished and members recon the burnt structure for victims. Little skill is needed for this type of search and little opportunity for survival is present for the victims in this operation (2002, Pressler).

Active search is a more common approach to the search tactic in the fire service. Members will be searching during the active phases of incident stabilization. Typically, they will be protected by the handline in tough conditions. Remaining in contact with the handline offers them orientation in low visibility environments. They will be searching in tough conditions
typically adjacent to the fire room but under the protection of the handline. They will be exposed to heat and other hazards but only advance as far as the line. The search will maintain contact with walls and other members as their efforts seek to keep certain safety influences intact. (2002, Pressler). Should the line fail to advance so to do the search efforts.

Aggressive searches are enterprising acts looking to reduce exposure time for victims. Firefighters will enter via windows from ladders decentralized from other members. Firefighters will work opposite handlines in areas adjacent to the fire and above the fire. The fire may still be unchecked by streams and worsening conditions. Firefighters in this posture incur a greater risk but the early nature of their engagement in the arena creates opportunity. Time is the limiting factor of survival; aggressive search reduces the time from arrival to rescue in firefighter resource deployment.

Ventilation is the removal of smoke and fire gases from the structure. Smoke and fire gases are a primary hazard to all involved at a structure fire. The purpose of ventilation is to reduce the exposure of this hazard to all life on the fire ground. Ventilation reduces the chance of flashover, increases visibility in the structure, reduces lateral fire spread and reduces the temperatures inside the fire structure. Ventilation is often coordinated with suppression efforts to enable their attack in punishing conditions. A stream hitting the fuel-flame interface creates an influx of steam whose pressure will rebound on the suppression team without a vent opening to release it from the structure (Fields, 2012).

There are three primary methods of ventilation deployed by the fire service: vertical, horizontal and natural ventilation. Vertical ventilation utilizes the fire’s natural means of convection by cutting a hole in the roof of a structure. Without this opening the fire and its gases will rise to the ceiling deflecting laterally and extend to other interior exposures. Vertical
ventilation also addresses confining the fire and protecting interior exposures by releasing the gases and extending fire from this lateral spread tendency. All ventilation efforts need to be coordinated with suppression or eventual fire growth will propagate due to the addition of air to the fire (Clark, 1991).

Horizontal ventilation is accomplished mostly by some means of mechanical fan use, pushing fresh air in from an open front door with a fan, or pulling air out from a window utilizing a smoke ejector. Natural vent is accomplished through similar means without the use of a fan. Natural vent is utilized in an aggressive search tactic called “Vent Enter Search” (VES). Members locate a window leading to a room with a possible fire victim. The members break the window venting smoke, enter the room and search for victims. The tactic includes the firefighter closing the doorway between the room and the fire thus compartmentalizing himself and the victim from the fire. This method of search is very effective at removing victims quickly, yet it is not universally deployed by all fire departments due to the perceived increase of vulnerability (B. Pressler, personal communication, July 9, 2019).

Fire service tactics all manage risk to some degree, but the intent of them can be delineated into one of two focuses in the initial moments of the fight…. where the opportunity to save a life is hanging in the balance. Tactics deployed on the fire ground are either victim focused, or safety focused. These are not paradoxical focuses as victim-based tactics can have safety implements just the same as safety focused tactics can have a positive influence on victim outcomes. The issues being addressed in this paper are concerned with the tactical deployment of resources which rob the victims of their most valuable resource…time. The victim whose respiratory tract is poisoned, burned and asphyxiated cannot afford response laden in positive influence…they need to be rescued.
Defining victim-focused tactics versus safety-focused tactics simply looks to evaluate the intent behind the tactic. Does the result of the tactic increase fire ground safety, victim survival or both? Rarely does a tactic have a clear-cut reduction of the survival window while at the same time increasing the safety of the fire fighter. An aggressive act on the fire ground is by its nature risk laden due to the timing of the event relative to the decreased tenability of the situation. Hence a firefighter whose duty becomes tenuous in this paradigm must make a judgement call to action.

One decision may increase safety for the firefighter, the other may increase survivability for those he serves. What influences this judgement is first off, the firefighter’s capabilities regarding the acts which are required: Can I throw the ladder efficiently, force the door quickly, or search the room with a violence of action maintaining my orientation? The secondary influence is an ability to assess the situation: Is the fire behaving in a manner which allows a search of this room, are the other fire combatants effective in their discipline of the operation, is the structure compromised, what is the victims chance of survival? The tertiary influence is psychological: Will my leaders condemn my actions, what can I justify, will I make it back out? The firefighter who chooses to act, amidst an increase of risk to personal safety and make proper situational judgements is by nature aggressive.

Aggression has many faces within a fire department and on the fire ground (Pressler). Do firefighters anticipate going to fires, and once at those fires, are they ready to deploy their resources in a fashion that enables a method of search which saves lives? Does the fire chief drill with his companies to establish the priority of operations as well as set the commanders intent? Does the organization create standard operating procedures which empower first-due companies to conduct decentralized operations focused on starting searches and other victim-focused
tactics? Is the officer of the first-due company making decisions that empower bold actions from his crew, or do key decisions limit their advance due to uncertainty? Does the officer choose safety focused tactics ahead of primary searches? Is the driver pumping the primary attack line establishing a water supply or throwing a ladder to enable the next due rig access to the second floor for a search? One act is victim focused the other is safety focused. Does their judgement (which drives action) within space, time, and position support the mission? Will the firefighter assigned as the outside vent enter the window before help arrives at the rear or delay until conditions are certainly safe? Many aggressive acts are opposed to what standards cite as ideal for the sake of safety yet circumstance rarely allows firefighters to follow all rules and effect rescue of a viable victim.

Aggression on the fire ground supports mission readiness. Aggression supports a posture to do what is required amidst the chaos of combat, a willingness to make judgement calls within the fog of war. Aggression needs to be nurtured by the department for it to be deployed. Firefighters not anticipating the arousal of victims or searching in tenuous conditions may be hesitant to do so in the moment of truth. Aggression needs to be drilled, chiefs looking to deploy aggressive acts with unskilled firefighters may be hampered in their intent.

Aggressive interior attacks with hand lines do have this influence as the tactic provides the most efficient means of base extinguishment, a truth known throughout the years of the fire service (Braidwood, 2016). The tactic increases risk to those on the hand line as they advance to the fuel flame interface in some of the toughest conditions known to the fire service (Dunn, 2006, p.83). Clearly an exclusively safety focused tactic would be to deny entry into the structure and place streams through windows or doorways from the exterior position of relative safety.
“Vent Enter Search” seeks to find the quickest route to the victim’s location. The special consideration of a window entry recognizes the fact that firefighters work in no-visibility environments in houses they have never occupied. Crawling through such an environment is arduous, disorienting and risky. Often the task is challenging due to these factors which are multiplied by active fire conditions. The window entry into a known room is much quicker than looking for the stairwell and feeling walls for the door leading to a victim. The intent behind this action is to manage time it comes at the expense of increased vulnerability to the fire’s hazards. Firefighters will be operating opposite from a handline (a deviation from safe practice), create a ventilation opening, and possibly working above the fire. All these issues increase a firefighter’s vulnerability, which is why many departments do not deploy the tactic. However, this risk-laden behavior provides a larger window of opportunity to rescue victims. Hence, Vent Enter Search is a victim-focused tactic with aggressive nature, for it seeks to manage additional risk for the victim’s sake at the expense of safety principles. Aggressive search operations also seek these opportunities as they forgo being tethered to the exterior with a handline for an expedited flow throughout the structure in search of fire victims. Often fire departments choose to search with a hand line, which becomes a task more focused on the management of the line (the line increases safety) then the survival window of the dying victims. UL tests have also provided feedback that not all structure fires need a handline for search tenability, the diagram in figure 3 indicates where firefighters can conduct searches and the timeframes associated with each hazard:

The operating range is red = seconds of survivability for firefighter in full ensemble, yellow is a matter of minutes regarding survivability in full ensemble, and green is tenable until fire spread continues with full ensemble. Refer to Fig. 3 below, the tenability is predicated on a
3” foot level where a firefighter would be induced to crawl accessing these tenuous spaces (Zevotek, Stakes, & Willi, 2018, p.181).

Hence searching with a hand line, prioritizing safety above victim need is a non-aggressive tactic unless the situation is so tenuous that the space to be entered requires the increased water application.

Safety implements often take additional time, resources and personnel. The waning moments of fire attack should look to optimize safety while managing the victim’s survival window. Tactics in the initial phases of fire attack should look to manage additional risk when they have a clear influence on a reduction of the victim survival window. Ventilation tactics convert the environment to increased tenability for all, an environment which is robbing victims of air. Aggressive search tactics lead to rescue opportunities. Aggressive hand line deployment kills the enemy whose elements are creating the issues at hand. These are victim focused tactics

Figure 3: Displays tenability for a firefighter in protective ensemble in researched structure fires. Zevotek, Stakes, and Willi. (2018). “Thermal conditions before (left) and after (right) water application down the hallway during an interior suppression tactic. Color conditions represent operating zones per Utech [31] where green is routine, yellow is ordinary, and red is emergency” p.181. The figure validates conducting searches without water application for the trained public servant.
and become the mainstay of a department whose post is unwaveringly centered on victim survival.

Chief Vincent Dunn (2006) provides a model of what aggressive firefighting is and what it is not in his book “Command and Control of Fires and Emergencies “Since most fires are extinguished by the interior attack team, usually very little strategic input is required from the chief. Generally, success is derived from ninety percent firefighter effort and ten percent strategy from the chief. However, if firefighters of understaffed companies didn’t operate above fires, and if nozzle teams didn’t advance into fire rooms, then the balance between firefighter effort and command strategy would change drastically in favor of the chief.

There might or might not be an increase in the number of casualties among civilians. In all likelihood, there would be a reduction of casualties among firefighters. One must always bear in mind that the priority of our profession is to protect life over property, and this includes the lives of firefighters as well as those of the public (Dunn, 2006, p.82).” A portion of fire departments across America do not deploy any of these procedures. A larger majority uncommonly deploy items 2,3,4, & 5 (Table 4).

A survey questionnaire backing this assertion was sent to firefighters randomly in the American Fire Service by the author. Social media was utilized to contact respondents for the survey through the website Facebook. Pages with fire service interest were poled. The respondents were provided a link to www.surveymonkey.com a website operated by SurveyMonkey Inc. San Mateo, California, USA. All results were analyzed by this company. Graphs were then created to quantify the answers creating quantitative data supporting this paper. The questions asked and graphs with respondent answers are shown in Appendix C-T.
The questions related to firefighter vulnerability, training standards, culture and fire department practices. The survey was taken by 442 respondents.

When respondents were asked if search and rescue operations are deployed without a handline in place routinely, only 40 percent agreed with this assertion (Appendix J). Furthering the view of uncommon procedures regarding search the questionnaire stated “Vent Enter Search” deployed routinely in departments was a 45 percent reality. Vertical ventilation is also a tactic uncommonly deployed in the nation where only 43 percent of departments surveyed use it regularly. We will refer to these practices as the “uncommon aggressive practices” throughout the text. The act of deploying hand lines interior to a structure, forcing doors, overhaul and working off tank water are more common occurrences. Thus, they are referred to as “common aggressive practices”.

Fire ground tactics should utilize firefighter equipment, manpower and available water to confine or extinguish the fire while minimizing damage to the lives and property of the occupants with due regard for the safety of all involved (Clark, p87, 91). Clarks assertion provides a pragmatic approach to the fire issue. Foregoing risk through use of aversion tactics is creates a combat ineffective response. The danger to all involved now increases. Victims peril is actualized, the fire departments purpose is marginalized, and the risk potential for firefighters has not vanished. The profession of firefighting is inherently risky. Safety practices are a responsibility of all involved, as is victim search and removal. Victim removal may create risk laden situations where firefighters have to confront unsafe conditions. The confrontation is a risk most aptly managed through dedicated drill, proper supervision, and coordinated effort.
<table>
<thead>
<tr>
<th>AGGRESSIVE</th>
<th>NONAGGRESSIVE</th>
<th>Key Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firefighters advance hose lines beyond the doorway into the burning room or hall.</td>
<td>Firefighters do not advance an attack line beyond the doorway. Additional hose lines are stretched to confine the fire</td>
<td>Limiting advance on fire / Stop loss attempt from relative safe position vs confrontation at fuel flame interface.</td>
</tr>
<tr>
<td>Firefighters operate on the roof to perform vertical ventilation</td>
<td>Firefighters do not operate on the roof above the fire. Horizontal ventilation is used instead.</td>
<td>Smoke vented less efficiently. Vertical risk exposure averted.</td>
</tr>
<tr>
<td>Firefighters enter buildings and search for the location of the fire before a protective hose line has been deployed</td>
<td>Firefighters do not search for the fire unless accompanied by a protective hose line.</td>
<td>Firefighter safety increased, time loss on fire discovery in lieu of hose line deployment</td>
</tr>
<tr>
<td>Firefighters conduct a primary search for victims before the fire has been extinguished</td>
<td>Firefighters do not conduct a primary search until the fire has been declared under control by the fire chief</td>
<td>Firefighter safety increased as incident stabilizes. Time loss on victim discovery / rescue in lieu of scene stability.</td>
</tr>
<tr>
<td>Firefighters perform search above the fire before the fire has been extinguished</td>
<td>Firefighters do not go above a fire until it has been declared under control</td>
<td>Firefighter safety increased by not committing personnel to dangerous area. Victims exposure to danger increases as duration in the environment is increased.</td>
</tr>
<tr>
<td>To vent smoke, firefighters break windows that can’t be opened manually</td>
<td>Firefighters do not vent windows unless ordered, and then only under the supervision of an officer</td>
<td>Scene remains hazardous longer in lieu of supervisory constructs.</td>
</tr>
<tr>
<td>Firefighters force open doors and locks when they suspect there’s fire in a room</td>
<td>Firefighters do not force open doors unless ordered, and then only under the supervision of an officer</td>
<td>Fire attack is stalled in lieu of supervisory constructs.</td>
</tr>
<tr>
<td>Firefighters break open plaster walls and ceilings, as well as cut open floors, to search for extension in concealed spaces.</td>
<td>Firefighters do not open plaster walls or ceilings, nor cut up flooring, to search for fire unless ordered, and then only under supervision of an officer</td>
<td>Fire attack stalls in lieu of supervisory constructs.</td>
</tr>
<tr>
<td>Firefighters use small-diameter hose lines (1 ¾” or less) for quick advance on the fire.</td>
<td>Firefighters stretch only large-diameter hose lines (2 ½” inches or more) at structure fires</td>
<td>Ability for quick advance limited by larger line, firefighter safety increased with exponential flow rate.</td>
</tr>
<tr>
<td>Firefighters attack a structure fire using a hose line supplied from a limited water source, such as a booster tank, rather than from a continuous supply, such as a hydrant</td>
<td>Firefighters do not perform interior attack unless they have a continuous water supply, such as from a hydrant or when drafting from a large body of water</td>
<td>Water application occurs sooner limiting fire spread. Continuous water supply reinforces firefighter safety.</td>
</tr>
</tbody>
</table>
Understanding why certain tactics are commonly deployed and uncommonly deployed is a central theme in the paper. The uncommon aggressive acts have the most influence on finding victims in the survival window (Pressler). Why are departments deploying tactics rooted in safety ahead of those that are victim-focused if the survival window is so tight and their purpose rooted in life preservation? Vulnerability seems to be a portion of the answer.

Firefighters feel more vulnerable in risk-laden situations such as search, and vertical ventilation efforts. Sixty percent of firefighters believe their vulnerability is increased searching ahead of an attack line or in absence of one (Graph 2).

Q3 My vulnerability on the fire ground increases when searching ahead of an attack line or in absence of one.

Graph 2: Survey monkey question regarding search vulnerability on the fireground. 442 Respondents replied. SurveyMonkey Inc. provided results and graph.
When asked why tactics having the most influence on the survival window are not commonly deployed Pressler indicated two reasons: 1. Lack of Fire Duty 2. Fear of getting firefighters injured.

When asked which departments deploy uncommon practices habitually, Pressler indicated those who have a regular fire duty. The experience factor influences the organizational perception, enabling effective outcomes from scenes practiced in the past. Fire departments that do not regularly see victims on fire grounds theorize about fires more often than experience them.

When this paradigm couples with training manuals focused on safe procedures over effective ones a reality exists in which a department trains towards common aggressive practices and those rooted in safety. The model follows safety standards and enables leadership the comfort of knowing their vulnerability to litigation is reduced as their firefighters will likely not experience much risk essentially the department becomes risk adverse.

Fire training grounds also neglect effective search operations. Pressler (2002) mentions this reality in his article “Aggressive Searches” as a primary reason the fire service is not reducing the number of fire fatalities. Coleman (2011), agrees with this assertion in his text Searching Smarter stating: “I guarantee you that most officers and firefighters never practice searching (3)”, when describing the scope of this problem. Bircault also makes mention of this reality in his book “Fireground Searches”, calling the paradigm, a “dying art” where the omission of realistic search training is producing unrealistic operations on firegrounds (Bircault, 2010, p4). When asked why the search curriculum is subpar if the act is the very essence of our mission; Pressler states that most departments will never respond to a scene with a trapped victim in a firefighter’s career (Pressler, personal communication, July 9, 2019)
The rarity of this event influences the perception of the fire combatant to the degree of combat ineffectiveness. The department is distracted with other drill initiatives, becomes habitual in their notion of fire attack and safety focused tactics without ever considering the impact these actions may have on future scenes with opposing needs. The instructors teaching search skills will rely more on curriculum than actual effective search operations as they lack the experience and have been rooted in combat ineffective practice for years.

**Do Aggressive Practices Induce More Firefighter Injuries or Deaths on the Fire Ground?**

Answering this question beckons the need to analyze data from actual fire events over time. The negative outcome which safety-focused tactics are employed to prevent is the base of the question. Fire service leaders need information and resources to properly prepare their firefighters for combat.

A thorough understanding of the factors influencing the safety of firefighters is paramount to preventing fire fighter injury and death. Equally important is a thorough understanding of those factors which most enable the fire service mission to thrive. The citizens trust the fire service to execute its capabilities with violence of action in dedicated effort to limit life loss. Clarity found as to the true extent of risk causations empower a department to focus on prevention of consequential events as well as promotion of opportunistic inducing actions.

A goal of the following research will be to answer the following two questions through data analysis:

1. What is the relationship between firefighter line-of-duty deaths and aggressive practices on the fire ground?
2. What is the relationship between firefighter fire ground injuries and aggressive practices?

*Summary of Data Collection:*

The population relating to these questions includes firefighters in the American Fire Service who have sustained injuries or line-of-duty deaths (LODD)’s. at structure fires in the United States. The variables measured in this quantitative research question are aggressive practices. Each LODD will be considered in the data as retrieved from the USFA database on LODDs, from the years 2000 through 2018.

The USFA retrieves firefighting data reported from 91 percent of fire departments located in the United States (United States Fire Administration). The aim will be to analyze causations leading to fatal events.

The data in this report will be analyzed to define LODD’s as a result of aggressive activities taken on the fire ground vs. those deaths due to other reasons (e.g., cardiac events). Specifically, the paper will focus on fire ground search and vertical ventilation. Aggressive actions include other tenets of the job; however, most fire departments conduct interior engine operations as a routine part of business.

Overhaul and forcible entry are also common practices in most departments. Due to these facts LODDs as a result of these actions also are intentionally omitted regarding aggressive tenets of the job. Furthermore, LODDs as a result of those actions did not account for any significant statistical relevance. LODDs relating to medical causations during an uncommon aggressive activity were also omitted as the nature of the death is not attributed to the degree of hazards encountered in practice. Firefighting in general is physically strenuous work, hence, statistically, injuries and deaths relating to medical causations are largely due to over exertion.
Trauma or thermal insult are typically caused by a practice which increases exposure of risk to the firefighter; rather than a medical condition. September 11, 2001 was a day which produced the most LODDs for a single event in the American Fire Services history. For the purposes of this research, those LODDs are viewed as outliers and not a part of the statistical relevance for this study.

The injury data reveals similar truths regarding activities producing injuries. This paper references work already conducted regarding firefighter injuries by the United States Fire Administration. The report addresses details of firefighter injuries “sustained at, responding to or returning from a fire incident, focusing on data as reported to the National Fire Incident Reporting System (NFIRS) from 2010 to 2014” (United States Fire Administration). The fire service reports incidents throughout the country utilizing a system called the National Fire Incident Reporting System (NFIRS). The injury data in this paper stems from accessing this

*Figure 2: Displays Firefighter LODD’s by activity for the years 2000-2018. Data as retrieved from the data base of the United States Fire Administration.*
system. Injuries include any event which a firefighter sustained an injury apart from exposures (chemical / biological); on some report’s, exposures are treated separately. Injuries will be tallied based on their occurrence per report.

![Firefighter Injuries by Activity 2010-2014](image)

*Figure 3: Displays Firefighter Injuries by Activity from the years 2010-2014 as retrieved from the data base of the United States Fire Administration.*

The data has been grouped in separate activities for ease of view. Common aggressive activities are described as those which most fire departments will employ on scenes across the United States. Those activities include extinguishing the fire, handling charged hose lines, using hand tools in extinguishment activity, overhaul, and force entry. Uncommon aggressive activities again are those this research is centered on ventilation with hand tools, ventilation with power tools and searching for victims.

*Summary and Interpretation of the Data*

Reviewing LODD’s since the year 2000, Fig. 2 depicts 1863 deaths occurred from activities other than uncommon aggressive practices. The total deaths for fire ground search and ventilation reached 59. This number is 3 percent of the total deaths over a 19-year span. The data suggests that views concerned with the relative danger of these efforts are exaggerated.
Interestingly the injury data associated with these activities on the fire ground portray a similar picture.

Search and vertical ventilation account for roughly 3 percent of all injuries which were analyzed in a five-year span 2010-2014 (Campbell, p.471, 2018). The population size in this report was 55,660 injuries. The injuries attributed to search and vertical ventilation were only 1,850. The data is not suggesting that search and vertical ventilation do not carry risk, however, when compared with other actions and causations of firefighter death or injury, the statistics reveal a marginal level of impact to the overall safety of firefighters.

Statistical Inference

A $z$-test was chosen to analyze a sample of proportion being the data quantity was greater than 30 with a normal distribution. The other qualities our data provides which indicate $z$-test for proportion is that it is independent of other variables and the events occurred at random fires. The data found regarding this research indicated activities enacted during a line-of-duty death.

The test of hypothesis in both questions of this paper was a one tailed test of proportion. The line-of-duty death data tracked 24 various activities leading to a death. Of these activities, ventilation and search were the uncommon actions this report is focused on. These two activities should account for a statistical mean around 12.5 percent of LODD’s. The expected value of 12.5 percent provides a basis for hypothesis testing.

Uncommon aggressive activities increase the chance for death on the fire ground.

The null hypothesis being: $H_0: \hat{p} - \hat{q} \geq .125$

The alternate hypothesis being: $H_a: \hat{p} - \hat{q} < .125$
The one tailed test performed shows a P-value of 6.49, or reject the null hypothesis. However, the z-score of our statistics show a P-value of 0.0000. Thus, we fail the null hypothesis stating that Uncommon aggressive activities increase the chance for death on the fire ground.

Data Analysis Results

Research Question 1.

Hypothesis Test: Firefighters performing search and ventilation (uncommon aggressive practices) have a greater probability of incurring injury on the fire ground.

Reject/Not Reject Decision: P-value = 0.00000, so reject the null hypothesis at α = .05. Conclude that the proportion of injuries due to these 3 uncommon aggressive practices is significantly less than 14.29%; in fact, it is only 3.3%.

The second hypothesis this paper tests is regarding the rate of injury on the fire ground.

Excel Figure 1: Z-test of firefighter injuries performing search and ventilation operations.

The sample of firefighter injuries spanned five years with approximately 55,660 injuries. The injuries are categorized by 24 different types of activities. The expected weight of the three activities which fall in the uncommon aggressive parameter is approximately 14.29 percent. The
data shows the result as only 3.3 percent of injuries are attributed to these uncommon aggressive practices. The z-score of -96.28 leads to a P-value of 0.000 again, rejecting the null hypothesis that these practices increase the chance for injury on the fire ground.

**Research Question 2**

Hypothesis Test: Performing search and ventilation (uncommon aggressive practices) increases the probability of death on the fire ground.

<table>
<thead>
<tr>
<th>Table 2. Hypothesis Test for Proportions - firefighter deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>p-hat = 0.1250</td>
</tr>
<tr>
<td>N = 1863</td>
</tr>
<tr>
<td># deaths by uncommon practices = 57</td>
</tr>
<tr>
<td>Proportion deaths by uncommon practices = p_0 = 0.030595813</td>
</tr>
<tr>
<td>S.E.(p-hat) = 0.008</td>
</tr>
<tr>
<td>Z-score = -16.28</td>
</tr>
<tr>
<td>p-value = 6.49E-60 one-tailed</td>
</tr>
</tbody>
</table>

P-value = 0.00000, so reject the null at α = .05. Conclude that the proportion of deaths due to these 3 uncommon aggressive practices is significantly less than 12.5%; in fact, it is only 3.05%.

Excel Fig. 2: Z-test for firefighter deaths performing search and ventilation operations.

Reject/Not Reject Decision: P-value = 0.00000, so reject the null at α = .05. Conclude that the proportion of deaths due to these 3 uncommon aggressive practices is significantly less than 12.5%; in fact, it is only 3.05%.

**Interpretation of Results**

The data clearly indicates no correlation with an increase in risk relating to vertical ventilation or search activities. Appendix A at the end of this paper shows the tables of hypothesis testing and the data analyzed. The results would indicate assumptions of this nature
are not based on the reality of how American firefighters are injured on the fire ground. Firefighters appear to not be overwhelmed with the additional risk assumed when partaking in search or vertical ventilation activities.

**Overall Conclusions**

The limitations to this study include the frequency of when aggressive practices are deployed. A thorough look at these statistics would consider how often aggressive acts are utilized. A future study may look to conclude the percentage of departments that practice aggressive tactics and look to compare their injury / LODD rate versus that of a nonaggressive department. The additional data to establish a baseline of worthiness would clarify the positive impacts of aggression on the fire ground. An accurate view of rescues made from nonaggressive acts proportionate to aggressive acts may reveal additional insight.

Data such as this would provide the basis for an incident commander to make true risk versus reward judgements on the fire ground. Further analysis would be to conduct quantitative surveys to verify the assertion which suggests a large part of the American fire service is averse to aggressive vertical ventilation and search procedures.

The reality of fire ground injuries and deaths is that they are largely caused by overexertion. Fire departments concerned with managing the welfare of their employees should consider deploying a comprehensive health and wellness plan. A plan which trains and develops firefighter’s resilience to the demands of the unforgiving fire ground. A decision to become risk averse by delaying search operations or avoiding vertical ventilation is not only invalidated by this research but may be a deterrent to all involved based on empirical findings of the profession.

**Do Uncommon Aggressive Practices Increase Rescue Opportunities?**
In the previous section of this paper tactical options were defined in how the fire service addresses the fire problem. There are several means of fire attack each with its own set of implications on the fire including possible victims, the structure as well as neighboring structures and the firefighters themselves. This section will focus more on the aggressive practices where firefighters operate without water and reduce time from scene arrival to victim removal. Specifically, the focus will be on the benefit of search operations whether that be without a line, above a fire or adjacent to the use of the handline and the action of ventilation. These acts represent the most aggression, risk and opportunity for life safety in the tactical arsenal of the fire service (Pressler). The paradox of risk and opportunity is a central focus of this paper. Do aggressive actions increase the likelihood of success on the fire ground via rescue?

An issue in the American Fire Service when considering lack of aggression on the fire ground relates to a lack of fire duty (Pressler). It is here that theory becomes more prevalent than practice. Principles are left open to debate when the reality of confronting a victim whose life is being attacked by the unsympathetic chemical chain reaction of fire is such a rarity the combatant no longer considers the actions behind his or her purpose. The following study seeks to assess the factors which truly impact rescue.

The most influential factor to survival is time. The earlier a fire victim can be reached, the better chance for survival. The firefighter rescue survey utilizes data from firefighters who have made rescues and recoveries around the country (Firefighter rescue survey data). The data presents a view of factors related to how those victims were rescued. Data includes where the victim was in the structure, fire conditions found on arrival, assignment of crews who found a victim, time taken to find a victim and remove that person, as well as victim outcome. The focus
of this analysis will be on victim outcome as it relates to time. The main factor a fire department controls regarding the demographics listed is time.

The purpose of the following study is to understand the most effective use of time on the fire ground. The study will define how much time is within the survival window and seek to validate which actions taken in this window optimize rescue opportunities. The result of which will provide a compass for fire service personnel to focus the intent of their efforts on that which is most befitting of their purpose. Time is influenced most pointedly by the fire service in its prioritization of tactics, along with the skill and aggression of those executing the tasks. Various portions of this report indicate the time tasks take to execute and will lead to further discussion of which tasks are most important at what stages of the firefight with the immediate supply of resources.

Once interpreted successfully the goal of this study will be to answer the following questions:

1. What is the relationship between time to find a victim and victim outcome?
   
   Hypothesis: There is a significant relationship between time to find victim and victim outcome.

2. What is the relationship between when search was initiated and victim outcome?
   
   Hypothesis: There is a significant relationship between search task prioritization and victim outcome.

*Summary of Data Collection*

The population relating to both questions in this study are American fire victims. The sample is those victims who were found by firefighters that took the voluntary rescue survey. The independent variable for both questions is victim outcomes. For question one the most
significant variable measured is the timeframes utilized to find the victim in the fire environment. The aim of this information will be to assess whether uncommon aggressive practices can influence victim survival by reducing time to victim found status. For question two the dependent variables are when search was initiated. Search is a task on the fire ground fit within the tactical operations of an active fireground. When resources are deployed to fulfill these objectives in relation to the overall strategic deployment of resources is the aim of this analysis.

The data is retrieved from: https://www.firefighterrescuesurvey.com, a website created by passionate firefighters looking to dissect factors relating to rescues made within the fire service for the sake of professional development. The survey is completely random and voluntary spanning 2016-2018. Participants who have knowledge of a rescue are asked to access the

![Figure 4: Displays victim outcomes based on the timeframes they were found in the structure by first responders. Data retrieved from www.firefighterrescuesurvey.com.](image-url)
website and take the survey questions. The results are made available to anyone with internet access.

**Summary and Interpretation of the Data**

Data was collected over a two-year span with approximately 892 respondents who experienced fire grounds with a removal of a fire victim involved. Of the 892 victims removed from a structure fire, 463 had a pulse, or roughly half of them. Approximately 63 percent of the victims found alive were found via the primary search team. The current condition of victims is unknown. Long term survival was not included in the data. Analyzing which time frames provide the highest success rate to victim survival we will use 50 percent alive as the standard towards combat effectiveness. When victims are found deceased over 50 percent of the time, we will consider these factors to indicate a combat ineffective state.

The benchmark for combat effectiveness occurs in the six minutes or less benchmark based on this standard. This timeframe is our survival window. Timeframes past six minutes have over 50 percent deceased victim outcomes according to the data. Actions taken within the first six minutes of scene time favor a positive victim outcome, and those past six minutes have dwindling returns associated with them according to this data. Fire service members should consider this information as they prioritize their operations and scene posture. Combat effectiveness considers aggressive actions taken within the first six minutes of scene time.

The primary search assignment is finding the victims most often, distantly followed by those assigned to fire attack. Fire attack is the term used in this data for the members advancing the primary attack hand line. Analyzing victim outcomes regarding time frames of when victims were found after fire department arrival reveals some truths to survivability. Situations where resources are limited in the first six minutes of scene time are a reality for departments across
Prioritizing which assignments allocate the most effective use of a department’s resources is clearly illustrated in the data in Graph 3. The primary search assignment finds substantially more victims than does the fire attack assignment. The other assignments on the fireground have very limited return on finding victims. The data supports a mindset of early resource deployment focused on attacking the fire to support the primary search. The first-arriving department’s resources should fill these two vital objectives to seek combat efficacy.

*Graph 3:* Depicts the assignment first responders were given when they found fire victims. Data retrieved from www.firefighterrescuesurvey.com

Further discussion is noted regarding search prioritization. Graph 6 views search in relation to other tasks on the fireground also found in the rescue data. Members filling out the survey had an option to indicate when searches on their rescue attempt were initiated. The options included pre fire or before fire knock down choices as well as before other assignments such as ventilation or rapid intervention team (RIT) assignments. This paper utilized the options
characterized as pre or before as the search prioritized rescue. The options including post or after fire knock down are considered search secondary. The nature of these observations cannot infer that all scenes deployed searches ahead of other assignments but clearly if victims were found before other benchmarks were accomplished, we can safely assume search was a tactical priority in the operational execution.

Interesting to note that most departments in this data (82 percent), prioritized the search ahead of or congruent with other tasks. The random survey of departments who responded to actual scenes with victims provides a glaring signal to the fire service. When responding to scenes with actual victims, aggressive searches became the most likely response. The notion of duty seems to be a fitting rationality for this reality. A survey of firefighter respondents was poled, asking if their department prioritized search ahead of other operational assignments.

Q27 My department establishes a water supply before assigning members to a primary search.

Graph 4
The questionnaire indicates that search is not routinely deployed on fire grounds ahead of other tasks.

The data indicated that 697 search efforts were prioritized on these scenes as compared with 152 respondents whose departments found victims post knockdown and after other assignments were completed. Search prioritized efforts had a success rate of 58 percent, removing a victim still alive (Firefighter Rescue Survey Data, n.d.). A rate seeking the combat effective notion mentioned previously. Where search became a secondary assignment conducted post fire knockdown 38 percent of victims removed had survived. These types of statistics further validate the notion survivability is about time, and time is influenced on the fire ground by task prioritization. Survivability is less about fire knockdown then it is about victim removal. The data indicates in the presence of victims on a scene, standards and past operational practice is not the prevalent influence for most departments’ actions. The sacred duty of firefighting is to

Graph 5: Graphs 4 & 5 display respondent data from SurveyMonkey Inc. asking 442 firefighters their departments operational priorities.
remove victims from peril immediately. Training and prioritizing any other actions only limit the departments innate disposition in the moment of truth.

**Graph 6:** Utilizes data retrieved from firefighterrescuesurvey.com indicating search prioritized assignments lead to an increase in survival

Statistical Inference

A chi-square analysis was chosen to analyze correlations of time to victim found and victim outcomes. To understand relationships within the categorical data and whether they are independent, this test provides an advantage in analyzing victim outcomes in relation to time. The goal is to definitively conclude that victim outcomes hinge on rescues made early in scene time. Departments will have knowledge of how these results can guide their operational prioritization on the fireground. The results of this analysis are shown in Graph 7.
Overall Conclusions

The American fire service has a clear duty to provide a means of rescue fitting the needs of the public they serve. The data analyzed provide the time frames of impact. Furthermore, to validate what tactical objectives are most effective, the study clearly displayed primary search as the task which finds the most victims. Performing primary searches in the first six minutes of scene time will lead to the best opportunity of life preservation.

The actions of primary search referenced within are independent of handlines. Searching with water is time consuming, distracting and not aggressive (Pressler). The first few assignments on the fire ground are critical to affect a rescue in the survival window. Deploying firefighters to attack the fire in an aggressive interior manner will position them not only to ensure a tenable environment for firefighters deployed on primary searches but also may enable

<table>
<thead>
<tr>
<th>Alive</th>
<th>Deceased</th>
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<th>Deceased</th>
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<td>Grand Total</td>
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<td>413</td>
<td>Grand Total</td>
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Chi-square value

Alive only: 3.41821E-08 Since this p-value is less than alpha = 0.01, the null hypothesis can be rejected in favor of the alternative.

Alive and Deceased: 7.79513E-20 Since this p-value is less than alpha = 0.01, the null hypothesis can be rejected in favor of the alternative.

Conclude that the time from scene arrival to victim found has a significant relationship with the victim outcome (alive or deceased). The nature of the relationship is that the longer the time to find the victim, the less likely the victim is to be alive.

Graph 7: Utilizes data retrieved from firefighterrescuesurvey.com displaying victim outcomes in relation to the time it took the fire department to find them in a structure fire.

**Overall Conclusions**

The American fire service has a clear duty to provide a means of rescue fitting the needs of the public they serve. The data analyzed provide the time frames of impact. Furthermore, to validate what tactical objectives are most effective, the study clearly displayed primary search as the task which finds the most victims. Performing primary searches in the first six minutes of scene time will lead to the best opportunity of life preservation.

The actions of primary search referenced within are independent of handlines. Searching with water is time consuming, distracting and not aggressive (Pressler). The first few assignments on the fire ground are critical to affect a rescue in the survival window. Deploying firefighters to attack the fire in an aggressive interior manner will position them not only to ensure a tenable environment for firefighters deployed on primary searches but also may enable
them to find victims enroute to the seat of the fire. The critical task of placing a hand line between the fire and the life exposure remains a combat-effective tactic. Deploying firefighters to satisfy water supply needs, back up line requirements or on a precautionary rapid intervention status has a negative influence on the time it takes to find victims. These acts are taken to the detriment of potential victims.

The data clearly reveals the impetus of first arriving combatants to deploy lines and search rooms. Any acts to enable these objectives such as: forcing doors, venting areas, throwing ladders to ensure access, egress and tenability of the space are that of the opportunistic effort on mission. Searching before the fire is under control has shown to have a positive influence on the survival window. Search efforts should be coordinated with suppression and not in a sequential manner. Searches deployed with violence of action have the most influence on victim survival.

Are Fire Service Training and Standards Mission Oriented?

The standards of the fire service are guided by an organization called the National Fire Protection Association, also known as NFPA. The NFPA is a United States trade association that creates standards intended to guide local governments in decisions regarding fire protection. Department training curriculum and delivery is varied across the United States. Departments whose budgets allow have training academies where much of the instruction is provided by members of their own organization. Smaller departments rely on local technical colleges to offer firefighting programs and certifications to indoctrinate their members into the craft. The curriculum utilized by either of these methods of indoctrination or a variation, is heavily influenced by NFPA standards. Certification is not within the control of the instructors who deliver the training. Certification is the duty of a separate entity who conducts testing to ensure
that the instruction received fulfills standards. NFPA standards are the consensus guides which this testing is certifying.

NFPA standards also have a heavy influence on how departments operate. The standards provide guides to acceptable levels of performance in all operational aspects of firefighting. Staffing, response times, equipment use, and many other factors are addressed by these standards. Essentially departments who are neglecting to follow these standards are doing so at their own risk of litigation should a calamity befall them.

Curriculum and the instructors who deliver it often construct these guides into specific actions during training. The organizations who create the curriculum are a separate entity as well from the school who employs the instructors and NFPA. There are many links in the chain of firefighter certification, which is essentially the foundation for a new firefighter. Each agency has their own parochial interests in mind as they deploy their part in this process. As an instructor employed by four different technical colleges, I learned of the influence the instructors had on content delivery.

Often it has been my experience that instructors prefer to deliver prepackaged cookie cutter programs, delivering Power Point slides without much additional insight beyond rehearsing the slide content. On the drill ground, often what is demonstrated is what was shown to the instructor years ago or what the textbook depicts. Rarely does the instructor look to review the standard and consider the intent beyond its surface level direction. This interpretation could negatively affect the performance of firefighters in the critical moments when a rescue is required. Their base line may not meet the performance needs of their combat reality. The lack of fire duty seems to create an overreliance on the interpretation of the standards (Pressler). Couple this interpretation with an instructor who has not managed a large degree of risk and the
theoretical directives issued will be inherently cautious as well as unrealistic. The student will likely then become risk adverse versus competent in managing risk.

NFPA 1710 provides guidance on deployment of resources during an alarm assignment (accompaniment of crews assigned to respond to a structure fire). The deployment of these resources is critical due to the narrow window of survival for potential fire victims. Equally critical are the interpretations of this standard and the timing in which tasks are completed. Figure 5 shows the requirements of NFPA regarding resource utilization.

Prioritization may be interpreted by the way these actions are numbered; however, the order of execution is not mentioned in the description of the standard. The standard (shown in Fig. 5) simply states that the first alarm assignment “shall provide for the following” and lists those benchmarks (NFPA, 2016). An important point in the NFPA standards is found in their intent (Fig. 6), which states the purpose of standard. The standard intents not to limit a fire departments’ standard of care but rather seeks to influence a baseline of operations. The intent is not to limit superior performance regarding department operations. It is my experience that most fire departments look to satisfy the minimum requirements without considering what superior performance entails. The beginning of this standard referenced its purpose in furthering life safety on the fire ground. Victim search and rescue as a resource assignment is executed fifth in the order it was carried out. The mission of the fire service places rescue as the ultimate priority; creating incongruence in understanding fire ground priorities. The experienced and victim focused department will begin addressing this threat immediately, basing tactical decisions on empirical findings. The safety focused, and less experienced department may follow the actions as they are interpreted in the standard, a theoretical based approach (Pressler). Very often though, due to these nuances departments prioritize operations through their interpretation of the standard, experience
threshold and personal litigious vulnerability beliefs. This interpretation materializes by reviewing the study NIST conducted to support NFPA 1710’s efforts. Both the NIST study and NFPA 1710 are mutually referenced within their contents.

The NIST research study executed tasks in a specific sequence to time staffing differences impact on the fireground. In Graph 8: NIST deployed tasks in the study with NFPA 1710 precepts in mind (Averill et. al, 2010). They executed tasks in a manner consistent with most fire departments interpretations of the procedure. The data created was to assist departments looking to provide city stakeholders with information on the lifesaving benefits of increased staffing.
Graph 8: average deployment times for assignments utilizing 5 person crews in the NIST study. The study experimented with live fires utilizing the timeframe of when the fire started. Typical response times aim for a 4 minute on scene fire service arrival. The research conducted aimed at supporting NFPA 1710 and provides a study to assist departments justification for increased staffing.
Search was not deployed in these tests until many other safety focused tasks had been addressed. The obvious inference to be drawn here is that NIST was testing operational flow which replicates most departments practices on the fire ground. Departments can than utilize this study to inform budgetary decision makers of their needs based on this accurate study of their operational procedures.

NFPA standards, even if at times being misinterpreted, have a mostly positive influence on the many facets of fire protection in America. The National Institute of Science and Technology (NIST) conducted experiments to understand the impact staffing has on fire department objectives. The outcomes of these objectives were cited in NFPA 1710, the most current version 2020.

The NIST staffing study conducted experiments, which provides a solid basis to understand the impact of tactics chosen in relation to the survivability of fire victims (Averill et al, 2010). We are reminded of earlier discussion where victim survivability hinges on time duration of exposure to toxic hazardous elements of structure fires. NIST utilized the same metrics (FED) as the UL studies to understand how staffing influences time factors impacting a victim’s exposure to FED. The elements tested were temperature within the compartment and toxic gas accumulation. Figures presented below signify that each factor was reduced by a dedicated commitment to increased staffing. Time-to-task analysis proves that dedicating resources to minimize victim exposure to fire elements has a positive effect on the total FED experienced by victims.

How does this information correlate to research conducted in this paper? As mentioned previously, departments across the nation vary in how they deploy their resources on the fire ground. Departments do not all deploy aggressive searches or ventilation operations. Often these
operations are suspended in favor of safety-focused practices aimed at reducing the vulnerability experienced by responding firefighters. Delaying the victim-focused tactics meant to reduce the FED exposure produces the same outcome researched in the NIST Staffing Study (Averill et al, 2010). Essentially the study quantifies the results of not committing staffing in a timely manner on victim survivability. The same conclusions can be drawn when a department arrives at an incident and implements safety focused principles ahead of victim focused principles. Allocating resources to tasks which do not reduce the victims FED during the initial phases of the incident places their lives in peril.

Data clearly states that a reduction of time is achievable from a concentrated staffing effort. The effort of reducing exposure to the FED by two minutes creates a 30 percent increase to the survival window. A large degree of discussion has been placed on search and rescue efforts to support survival through removal. However, these illustrations also present compelling arguments to the positive effects of aggressive ventilation efforts. The conversion of a space from untenable to tenable cannot be overstated. A fresh air environment begins the rescue process prior to the demanding task of removal. Oxygen environments above 16 percent support life (Clark, 1991). The time to task trials show the conversion of this hazard through firefighter effort. Once more the data indicate a dedicated resource deployment effort yields victim focused results decreasing their FED to hazards.
NFPA 1710 guides fire departments to effective deployment of resources. A section developed states its purpose succinctly:

1.2 *Purpose.*

1.2.1* The purpose of this standard is to specify the minimum criteria addressing the effectiveness and efficiency of the career public fire suppression operations, emergency medical service, and special operations delivery in protecting the citizens of the jurisdiction and the occupational safety and health of fire department employees.

1.2.2 Nothing herein is intended to restrict any jurisdiction from exceeding these minimum requirements.

1.3 *Application.*

1.3.1 This standard applies to the deployment of resources by a fire department to emergency situations when operations can be implemented to save lives and property.

1.3.2 The standard is a benchmark for most common responses and a platform for developing the appropriate plan for deployment of resources for fires in higher hazard occupancies or more complex incidents.

1.4* Equivalency.* Nothing in this standard is intended to prohibit the use of systems, methods, or approaches of equivalent or superior performance to those prescribed by this standard, provided technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency.

*Figure 6: Screenshot from NFPA 1710 Standard for the organization and deployment of fire suppression operations, emergency medical services and special operations to the public by career departments (2016). Introductory comments of standard.*

Special attention can be paid to verbiage establishing the standard as a benchmark for a high standard of care, not to be minimized and more importantly not to limit any departments whose prerogative is such to enhance the standard. Further research of this standard display’s importance to the management of time. Figure 7 points to the time management constructs of the standard as a guide ensuring a standard of care in emergency response.
Fig. 7: Screenshot from NFPA 1710 Standard for the organization and deployment of fire suppression operations, emergency medical services and special operations to the public by career departments (2016). Cascade of events chart

5.2.2* Staffing. The number of on-duty fire suppression members shall be sufficient to perform the necessary firefighting operations given the expected fire-fighting conditions.

5.2.2.1 These numbers shall be determined through task analyses that take the following factors into consideration:

1. Life hazard to the populace protected
2. Provisions of safe and effective fire-fighting performance conditions for the firefighters
3. Potential property loss
4. Nature, configuration, hazards, and internal protection of the properties involved
5. Types of fireground tactics and evolutions employed as standard procedure, type of apparatus used, and results expected to be obtained at the fire scene

Figure 8: Screenshot from NFPA 1710 Standard for the organization and deployment of fire suppression operations, emergency medical services and special operations to the public by career departments (2016). Factors which influence task prioritization on the fireground. Life is the fire service priority.
A timely response to the scene is but one measurable factor which guide those departments whose impetus is compliance. Further research into the standards appreciates its ability to prioritize the execution of tasks upon arrival. Here again we see the focus is on the mission of the fire service – life.

Table 5 shows the FED victims are exposed to in relation to search deployment times. The table also depicts the dynamic nature of structure fires, some are slow progressing while others are rapid in progression. Rescue time is misleading in the table, as the study indicated search time duration was not recorded in the study due to the inability of experiments to produce reliable results. Exposures depicted in this graph of FED are from a point of when the actual search tactic was initiated, with a timer start point of fire ignition. Comparing fire ignition start time to NFPA 1710’s total response time standards, which direct departments first in company to be arriving on scene at approximately the seven-minute mark post notification. One can infer that should a search be initiated at the seven-minute mark victims would have less than eight minutes of search time before maximal FED is capacitating. A search of five-minutes or less would be optimal utilizing information contained on this chart.

<table>
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<tr>
<td>2 Early</td>
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<tr>
<td>5 Early</td>
<td>8:57</td>
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</table>

KEY
- **White**: 89% or more of population may be capable of effecting their own escape if they are able.
- **Yellow**: Potential for certain sensitive populations (such as children and the elderly) to become incapacitated.
- **Red**: More than 50% of the population would be incapable of effecting their own escape.

Table 8: FED as a Function of Deployment Configuration and Fire Growth Rate
The study also calculated the FED of victims in a room on the floor above the room of origin. While this location is still dangerous rooms adjacent on the floor of the fire are most at risk for victims (Zevotek, Stakes, & Willi, 2018). Victims found in these rooms will surely be suffering increased rates of FED. Further analysis should include how long it takes to complete a search and include the duration of rescue / removal activities. Victims are still exposed to the death inducing elements of fire unless prompt removal and ventilation occur.

Further consideration points to victims not receiving life intervening efforts from EMS until they are out of the structure and CPR is initiated. Delaying CPR for ten minutes equates to near certain death for the victim in cardiac arrest (American Heart Association). The times listed in the chart also can be a bit misleading. The start time utilized is from fire ignition; fire department arrival time is noted at the NFPA desired standard for arrival of four minutes. The chart illustrates a point made earlier in this paper that prioritizing search late in tactics costs a victim five minutes of search opportunity even with a resource-heavy department at a fast-moving fire, the opportunity to rescue a viable victim is dwindling. Should we add the time it takes in duration to conduct the search, and rescue the victim, we find a bleak scenario possibly occurring. Standards may be fulfilled here, but combat effectiveness lays in the balance and, ultimately, the victim’s individual resilience now maybe the greatest influence on survival, even over the department’s boldness in action. Should this paradigm become reality, a department essentially is combat ineffective.

Table 5: Displays FED victims in rooms above test fires were exposed to, noting that fire start time is not the same as fire department response time. Seven minutes is the NFPA 1710 std for fire department total response time. The chart here shows departments completing aggressive searches in the Survival Window will be giving victims a chance based on this study. Table found in NIST Staffing Report (Averill et al., 2010).
The number one priority of the agencies employed to respond to emergencies is to respond quickly to the alert of an emergency. Once on scene, the resources that have arrived have a prioritization of task execution. The focus of this priority is to address the life hazard according to standard. The tasks which should be deployed first with violence of action are those which are victim-focused.

A note on how standards can be manipulated to decrease the standard of care regarding fire service mission attainment: Search operations create risk management opportunities.

Searching for victims apart from a protective hose line is a dangerous endeavor. Figure 9 shows the NFPA’s recommendations regarding fire ground search. Crew members being in contact with each other has led to interpretations by fire service leaders and instructors which has harmed victim focused efforts. The verbiage states “communication with each other,” not necessarily by physical or safety guide means. Often taught is an effort to avert risk by having members manage a protective hose line or maintain physical contact with each other as they conduct their search effort. The effect this safety focused implement creates is an increase in the

8.6.4* Members operating in hazardous areas at emergency incidents shall operate in crews of two or more.

8.6.5* Crew members operating in hazardous areas shall be in communication with each other through visual, audible, or physical means or safety guide rope, in order to coordinate their activities.

8.6.6 Crew members shall be in proximity to each other to provide assistance in case of emergency.

8.6.7 In accordance with the requirements of 8.8.2, at least two members shall be present outside the hazardous area available for assistance or rescue at emergency operations where members are operating inside a hazardous area.
time to search. Having two members search the same path is redundancy in effort at the expense of the survival window. Managing a hose line not only slows the progress of would be searching members but increases their task responsibilities in an unforgiving atmosphere. Search focus should be dedicated to only looking for trapped, overcome occupants to induce an effective enterprise. The focused firefighter needs to narrow his task to the priority of search. John Coleman (2011) supports this sentiment in his book Searching Smarter “the more smoke and heat present in a fire building, the less effective multitasking becomes (p26)”. The perception of vulnerability seems to induce the need to teach risk aversion tactics. The perception is creating a lesser standard of care for the citizens. The perception is creating a combat ineffective reality.

The OSHA standard of “2 in - 2 out” is also having a negative influence on the survival window. Departments seeking to meet the requirements of this standard do so at the expense of the survival window. The staffing studies combined with the victim survival studies clearly state the most effective use of resources regarding the survival window. Adherence to this standard is often a liability covering endeavor mostly forgotten in the moment of truth. Standards contain verbiage to alleviate the concerns of leadership stating deviation is permissible should life safety be in question. However, these judgements are unrealistic to make when considering the arousal of all involved on arrival at the fire scene. Choosing which scenes to be initiated and which to punt on is a losing game when considering the six-minute survival window. Further research has shown that the benefits behind the implementation of 2 in - 2 out are not being realized on the fire ground. Don Abbotts research of Fire ground Maydays describes a reality that the OSHA
Standard of 2 in - 2 out is ineffective (n.d.). Abbott describes the standard in the following manner: “2 in / 2 out, our research, based on victims, ICs, IRIC/RIC does not work. It has not produced any desired results…to few people, not properly dressed, no RIC bag, mentally unprepared, no plan, no back-up plan or team (n.d.). Further research Chief Abbotts Mayday project alluded to the fact that near 87 percent of Maydays were resolved by the working companies inside the structure (Abbott.D, n.d.). The 2 in - 2 out (IRIC) or resources allocated to any form of RIT are being utilized for a rare occurrence and are only 6 percent effective to their intended end. Designating critical resources during a critical time which are rarely deployed while being only 6 percent effective when there is a firefighter mayday is a check box safety focused allocation of tactics. The fact that interior crews make the majority of the 87 percent of rescues when firefighters have survival emergencies at structure fires lends credence to the notion that interior firefighters focused on rescue for fire victims is also more effective use of combat force than staging personnel waiting for something bad to happen.

**Summary and Conclusions**

The American Fire Service exists to rescue entrapped citizens from structure fires. Every piece of apparatus, system designed to deploy firefighters, ensemble aimed at protecting them and tool found within their arsenal is for the purpose of interior offensive operations. Aggressively utilizing these means is critical for the effect it has on victim survival possibilities. Research indicates that unrealistic training creates unrealistic fire grounds. Lack of effective training is hampering firefighter’s efficacy on fire grounds. A voluntary survey of firefighters finds that only 40 percent of fire departments surveyed provide annual live fire training for their members. One live fire drill a year for a profession whose actual fire duty continues to shrink is the minimum to prevent substantial regression in skills. Most departments
are not even fulfilling this requirement. How skilled can a department be at arduous tasks with such a rare practice model?

The victims in peril have a survival window of six minutes or less. The firefighter confronting this reality will do so in tough conditions, often with less than appropriate training models to pre-condition that firefighter to confront any risks that aggressive searches and ventilation induce. Likely the firefighter will need to face those fears in the situation. The reality is clearly stated by UL: “If a victim can survive the environment, risking crews on an interior search prior to fire control is of greater benefit than if no survivable spaces exist (UL p.177).” Those actions need to be aggressive and victim focused as further clarity is found in the studies: “Immediate intervention, involving suppression and ventilation is necessary to increase the survivability of all spaces in the structure (Zevotek, Stakes, & Willi, 2018, p.178).” Often safety-focused tactics will detract resources from producing this tenability and removal of victims.

Leadership and organizational behavior also influence the ability a firefighter has on acting in moments of victim need. Organizational culture highly impacts how things are done and what behaviors are tolerated. The same notions of bold action incumbent on the firefighter is required of the leadership. Instead of bold action however, leadership is charged with bold intent through directives. A leader may empower his department to take this action through operational procedure and posture.

The studies found within this research define aggressive behavior on the fire ground. They state that in moments of opportunity the bold act and the skilled perform to the standard of the truly vulnerable - the fire victim. Survivability is dynamic based on the individual in such environments but defined in this paper we can certainly say that not finding a victim in the first
six minutes of a fire event greatly reduces the possibility of survival. Finding a victim after ten minutes becomes an investigation and recovery effort. The studies discussed why those practices which optimize efforts in this six-minute effort are not universally practiced and remain uncommon amongst fire departments across America. The study aimed to disprove some of the perceptive fears of these acts and provide a bit of reality relating to the true vulnerability of those executing them. Competence will always prove to be our biggest asset in safe fireground operations, and aggression in effective victim focused endeavors. Finally, the study gives credence to the true impact aggressive searches produce in the survival window. The study did not prove this endeavor does not carry risk; however, it does indicate a clear benefit for the unprotected.
Figure 7.5: Fractional effective dose (FED) of thermal exposure based on total flux to the surface. Top left is the no ventilation case, top right is the single vent with a single room of fire case and bottom is the two rooms of fire with two vent case. The shaded areas represent the various +/- one standard deviation for the average value recorded.
Figure 7.6: Fractional effective dose (FED) of toxic gas exposure based on CO, CO₂ and O₂. Top left is the no ventilation case, top right is the single vent with a single room of fire case and bottom is the two rooms of fire with two vent case. The shaded areas represent the various +/- one standard deviation for the average value recorded.
Appendix C

Q20 The culture in my department influences my actions on the fire ground

Q27 My department establishes a water supply before assigning members to a primary search.
Appendix D

Q4 My vulnerability is reduced when searching with an attack line or off of it?

Q3 My vulnerability on the fire ground increases when searching ahead of an attack line or in absence of one.
Appendix E

Q3 My vulnerability on the fire ground increases when searching ahead of an attack line or in absence of one.

Q8 My department performs Vent Enter Search operations regularly
Appendix F

Q9 I would describe Vent Enter Search tactics as an aggressive practice on an active fire ground.

Q10 My department performs vertical ventilation when combustion has reached the top floor?
Appendix G

Q11 My vulnerability on the fire ground increases when performing vertical ventilation

Q13 My department views vertical ventilation as a necessary tactic?
Appendix H

Q14 I would describe vertical ventilation as an aggressive practice on an active fire ground

Q31 Transitional attacks decrease my vulnerability on the fire ground
Appendix I

Q27 My department establishes a water supply before assigning members to a primary search.

Q7 I would describe conducting a primary search without an attack hose line an aggressive practice on an active fire ground.
Appendix J

Q5 My organization performs search operations before incident stabilization is attained.

Q6 My department performs search and rescue without an attack line in place routinely?
Appendix K

Q29 My department assigns personnel to Rapid Intervention Team before assigning personnel to conduct a primary search on an active fire ground.

Q12 My department performs vertical ventilation regularly.
Appendix L

Q17 NFPA Standards seem to be subjective and open to interpretation.

Q16 NFPA Standards guided much of the curriculum in my Fire Service certification training.
Appendix M

Q23 NFPA Standards are open to interpretation

Q33 My departments live fire training adequately prepares firefighters for their job?
Appendix N

Q25 My department initiates interior offensive attacks without a continuous water supply from a hydrant.

Q15 My department looks to follow NFPA Standards
Appendix O

Q34 How would you define your current structural firefighting training in its ability to prepare you for actual firefighting:

Q28 My department establishes 2 in / 2 out requirements before establishing a primary search
Appendix P

Q21 My department values NFPA Standards

Q35 My departments introductory training reflects the departments fire ground practices.
Appendix Q

Q24 My department routinely conducts interior offensive attacks at structure fires

Q26 My department deploys secondary back up attack lines before assigning members to a primary search
Appendix R

Q25 My department initiates interior offensive attacks without a continuous water supply from a hydrant.

Q22 My department follows NFPA Standards
Appendix S

Q19 To what extent does your departments culture influence fire ground practices.

Q18 My department follows OSHA's Regulation of 2 in / 2 out.
Appendix T

Q30 My department deploys transitional attacks at structure fires?

Q32 My department conducts annual live fire training?
References


United States Fire Administration


NFPA 1710 Standard for the organization and deployment of fire suppression operations, emergency medical services and special operations to the public by career departments [NFPA Consensus Standard]. (2016). MA, Quincy.


Bob Pressler is a Firefighter with over 40 years experience, over 30 years instructing, partaking in all the ranks from firefighter to Fire Chief. He has instructed in nearly 40 states, watched or participated in actual fire grounds in approximately 20 states. Led all hands on training at the largest Firefighter Conference in the world: Fire Department Instructors Conference and still teaches fire training regularly as a lead instructor at the Fire Department Training Network whose live fire training curriculum and methods are nationally replicated.

Procedures for interior structural firefighting. As found on the web at:


(4)


Line of duty death data from 2000-2018

