Fire Engineering

IMPORTANCE of FIREGROUND VENTILATION PRACTICES and DYNAMICS IN FIREFIGHTING (PART II)

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UL (Underwriters Laboratories) and NIST (National Institute of Standards and Technologies) Ventilation Limited Fires

New technology studies through these organizations has provided some new considerations and dimensions in our strategic and tactical approaches to ventilation in both contemporary and legacy residential construction pertaining to fire behavior. Predominately these studies have revealed the true nature of fire showing when we arrive on the scene and our efforts in providing more ventilation to a structure especially in the areas of horizontal ventilation. The revelations are of such magnitude that it is now apparent that increasing horizontal ventilation openings even beginning with the first additional opening of the front door as firefighters prepare to advance the first line actually creates more untenable fire conditions in our efforts to advance to the seat of the fire. Many department practices emphasize the incorporation of ventilation for not only the release of fire gases and heat but also for the purpose in helping locate the fire. The bottom line here through these studies is that fire companies should not be prohibited from opening up the structure but should rather consider the new consequences of creating multiple and random ventilation openings especially when the true area of the fires location is not known.

The utilization of horizontal ventilation openings even beginning with the front door provided for the fires response from the additional air in creating faster fire growths while the structure can still be considered ventilation limited. It also allows for fire within a structure to maintain higher temperatures versus the structure being more closed. What this is emphasizing to the American fire service is being prepared in establishing coordinated fire attack with ventilation while also making us understand that any existing or additional ventilation is providing air to the fire allowing it to sustain and grow. The considerations of fire companies and their officers should be in their attempts to locate fire while getting to the seat of the fire is the ventilation tactics that are initiated at the fire. Considerations should be given to how many windows or how many doors should be opened before our attempts in locating the fire. The importance of sizing-up a fires

location and providing ventilation to help maintain tenable conditions can be problematic if firefighters aren't paying attention to several factors such as building construction and layout. This along with experience improves our decision making process.

Tactical Vertical and Horizontal Ventilation in Structural Firefighting

There are only so many options available at structural fires when it comes to a sound tactics and strategies involving vertical and horizontal ventilation. Many of our tactics and strategies regarding providing ventilation of either type is the type of structure presented to us. Some of the key elements in providing ventilation openings are the considerations involving structure types along with enough personnel to conduct this important coordinated tactic. What also should be considered are its dangers to firefighters that may not have acquired the skills along with the decision making strategies in accomplishing this fine art because of lack of training and experience. We are seeing increasingly more departments with limited staffing and safety concerns about always sending guys to the roof. Firefighters have died through collapse and flashover conditions while performing roof operations at several different structure types. The decision to ventilate whether horizontally or vertically by Commanders, officers and their members should be in knowing the possible results in participating in these tactics. The following considerations should be given and realized before and during coordinated fire attack.

Ventilation Considerations

- **Any opening provided whether vertical or horizontal will change the fires development.**
- **When available utilize thermal imaging technology to help locate fire and high heat conditions.**
- **Ventilation Increases the speed of heat release rates raising temperatures more quickly.**
- **Ventilation-limited structures upon arrival require a coordinated fire attack with water application in a timely manner.**
- **Any offensive procedure incorporating advancing hose lines through door openings provides changes in fire growth and heat release rates.**
- **Any fire that is free venting with adequate flame and fire gases should be considered as a adequate ventilation opening providing time through water application from outside and then going inside.**

- **Consider any search techniques being conducted prior to advancing a hose line to be extremely dangerous especially when opening windows. Control doors and windows at all times.**

Residential structure fires involving homes up to 2 ½ to 3 stories for most departments are obtainable in placing and providing ventilation in key areas. The spectrum is wide and more difficult many times in establishing adequate ventilation when it comes to residential living involving multiple floors such as multi-dwellings and high rise structures. There are also key issues with commercial buildings as well as large assisted living occupancies and high life hazards such as hospitals. Many times in many of these types of structures we have to really on horizontal ventilation or some form of air handling systems designed into the building to ventilate. It seems logical to assume and understand that the higher the structure the more difficult it is to properly place and accomplish ventilation with coordinated fire attack. It is also safe to assume that the lower we go into below grade areas such as basements, underground garages and bunker style construction we face the same if not more limited ways of providing ventilation.

In this survival doctrine we will be looking at vertical and horizontal ventilation at residential fires regarding relationships between ventilation tactics, operations and engineered lightweight construction systems. Since we know that vertical ventilation of these types of structures is to be obtained as high above the fire as possible we need to address the obvious and that is the lightweight roof a definitive firefighter killer. The new modern day fireground is much more dangerous as we know due to synthetic materials increasing higher and faster heat release ratios when involved in fire creating more volatile thermal layers throughout a structure. Unfortunately new building construction consisting of engineered lightweight construction does not have the same integrity and resistance to fire as the older dimensional or conventional lumber used in the past. Also affecting their construction is the way they are put together. Generally speaking the older construction features involved dimensional lumber assembled with lengthy nails along with nuts and bolts for many assemblies. These days its I- joist with holes through them assembled with glue and trusses assembled with shallow plastic and metal gusset plates as well as glue laminates in many cases. Even the use of I-joist type of assemblies with their orientated strand board is being incorporated into roof assemblies. These types of construction methods are verified as providing heavier loads which have remarkably increased their ability to span further throughout a structure. However their exposure to fire and heat especially at higher heat release ratios from synthetic materials in their ability to hold their structural integrity is greatly diminished and causes huge concerns for the fireground and ventilation efforts. In fact many of these structural members are failing from just heat exposure without flame impingement. Still knowing all these firefighters are needed to perform the most chosen tactic of vertical ventilation

and that is roof ventilation operations on lightweight roofs above interior fires. This involves modern day constructed roofs of all types including metal roofs, corrugated metal roofs, metal deck roofs and wood roofs made up of less than 2 x 6 lumber replaced with 2 x4 truss or I-joist construction. Another consideration factor is the various spans of engineered light weight truss systems incorporated into not only residential but all types of structures and their assembled roofs. Conventional or older roof assemblies consisting of old lumber using 2x6 and even larger assemblies provide more time to firefighters conducting roof operations when cutting ventilation openings. The many types of ventilation cuts made above fires along with trench cutting in some cases takes time and could in the past be conducted with some certainty to withstand fire impingement and the live loads put on the roof during our operations.

The same factors relating to older construction involving old wood dimensional lumber in roof systems of the past to modern day engineered systems when considering vertical ventilation now requires a new set of considerations. The viability of roof ventilation on light weight roofs can be challenging for many departments especially when faced with minimum staffing or have additional incoming units possibly causing delays in the important timing of ventilation with hose line advancements. The impingement of fire and heat to light weight roof construction and its potential for collapse can be as little as 5 to 7 minutes depending on fire conditions. Arriving companies with a 4 to 6 minute response time before arrival while also factoring in preparation efforts upon arrival and finally stepping onto a light weight roof should raise concern along with a conscious approach that ventilation may not be possible.

The viability of recognized light weight roof operations at structural fires should be considered a roll of the dice in the minds of firefighters and chief officers while not recognizing the presence of light weight roof assemblies can be catastrophic to our members. Simply put roof ventilation operations on lightweight roofs are unsafe when fire and heat are compromising the roofs structural members. This is not to say that ventilation needed at another portion of a roof cannot be addressed but only if it is truly necessary. If fire is venting through a lightweight roof system at a given structural fire we need to examine if providing another ventilation opening is appropriate. Fire and heat move quickly through lightweight roofs and sizing-up the roof for additional ventilation is very important. What is the span of the roof? How much fire and smoke is venting from the existing self vent opening? What is left in its integrity to the rest of the roof? Are there several different pitches to the roof from other connecting roofs? In all of these questions there is only one answer you should arrive at if fire and heat has possibly affected the rest of the roofs assemblies to fail and that is, stay off the roof.

Roof operations involving light weight construction can be safe when there is a full understanding and a complete size-up of the presenting conditions when we arrive at structural fires. When fire and heat has not compromised the structural members we

can provide ventilation with an adequate assumption that safety and the time to perform it are in our favor while still realizing that during our presence on the roof things can change quickly.

Ventilation Profiling

Normal Ventilation: Exchange of air from the inside of a structure through to outside air, allows sustained combustion and smoke release.

Unplanned Ventilation: Caused by fire effects, human interaction, doors and windows left open or their failure caused by fire and heat, firefighter entries and uncoordinated ventilation, speeds fire development.

Wind: Direction and force, speed, fast moving fires and unplanned draft effects throughout the structure, speeds fire development.

Tactical Ventilation: Planned, coordinated, improves conditions, aids in effective and coordinated fire attack and control, increases safety and survivability of occupants and firefighters.

Tactical Confined Ventilation: Intentional, systematic confinement, exclusion of air, prevention of smoke movement throughout the structure, still needs fire control and extinguishment.

Safety Considerations in Roof Ventilation Tactics and Feasibility

Applying safety concerns along with our tactics to roof operations at structural fires we need to provide some rules of engagement when viable conditions allow us to put are members on a roof. Any ventilation operations that departments engage in should have a solid set of operating guidelines and training exercised regularly to those guidelines to its members. In order to increase survival and avoid injuries the following tactics should be considered for members participating in the offensive procedures of roof ventilation.

Size-Up: The type of structure, construction, number of floors, presence of attic spaces, connecting roofs to other parts of the structure and to other buildings, common roof to multiple structures, extension of smoke its color and velocity, exposed rafter tails determining size and span of construction, type of decking.

Ladders: Proper size ladders, minimum of 2 ladders (roof and extension), provide for secondary means of egress, work on the strong side of the roof working back to your means of egress.

Tools and Equipment: Full PPE and SCBA, pike pole, halligan bar, trash hook, pick head axe, potable radios, and powered saws.

Stepping on the Roof: **Sound the roof, feel the strength of the roof, supports the weight of personnel and equipment, determine a safe path of travel to the area to be ventilated.**

Reading The Roof: **Look for smoke from natural ventilation openings (soil stacks, chimney vents), smoke color, density and velocity, fire extension into the attic, fire extension from windows lapping flame, determine ventilation feasibility, the amount of time available for cutting the ventilation hole and getting off the roof.**

Determining Roofs Material Make Up: **Conventional or lightweight, roof covering (Tile, Shingle, Slate, Metal), OSB, Tongue and Grove, Cut an inspection plug to determine roofs materials, multiple layered materials.**

Determining Location and Extension of Fire: **Areas of smoke push, skylights, vent stacks, areas of fire or heat (roof materials blistering or discolored, melting snow, bubbling), provide small inspection holes (kerf cuts) to determine fire and smoke location, if fire is present you may need to move back towards your egress and cut there, avoid working directly over fire coming from an inspection hole.**

The above roof ventilation considerations are mainly information gathering while operating on roofs. When the decision is made to commit to the actual operations of cutting a ventilation hole all personnel on the roof should know their part in using the tools for the operation while the company officer keeps a watchful eye out for those operating powered saws and hand tools. The company officers eyes are also vigilant for changing fire conditions and the roofs integrity at all times. Members should know to walk the strong areas of the roof while sounding their path of travel. Always work from the weak area which is where you are conducting the ventilation operation to your strong area which should be towards your egress point off the roof. Firefighters especially using powered saws should be careful in knowing the depth and control of the cuts being made. Deep uncontrolled cuts can severe key structural members providing support for your operations.

The importance in determining the location of roof ventilation openings cannot be overstated. Usually we provide openings above and as close to the fire as possible. This should not mislead firefighters into thinking that it has to be right over the fire for this would put crew members in a dangerous position. In certain situations thermal imaging can help locate high heat conditions absorbed into the roofs materials indicating the main body of fire below in the interior. Remember that tunneling in on thermal imaging on a roof is very dangerous just as its tunneling effect on members involved in interior operations. Perform ventilation in areas that are safe to do so. Close to fire is preferred where as to far away from a fire burning below can draw fire above

and behind forward advancing hose lines unaware that fire has moved behind them possible making fire conditions on the interior untenable. Once ventilation is completed all members should revert back along their safe path of egress and get off the roof.

Firefighter Impact Loads on Engineered Roof Systems

As we know fire and heat that is impinging from the interior to I- joists and roof trusses involving lightweight construction change the ability of these structural elements to carry the weight they were originally designed for. The building elements that were originally designed to support each other when impacted by fire and heat are now under changing conditions of their load bearing abilities. Fire and heat change the load bearing design features throughout a structural fire many times without firefighters even given a warning of their imminent failure. When firefighters enter structures across fire effected I-joist or step onto roofs that have had fire and heat weaken their intended performance they may be adding an impact load that causes their collapse. Collapse in the fire service has killed and injured many firefighters over the years and should be considered a threat at every structural fire regardless of the building type. We should realize that no matter what we do with our body weight and are equipment that are placed on roofs that even the smallest amount of loading can cause collapse. Even as we move about on the roof and working with tools the loads are in constant motion to any given area with the possibility of structural failure, especially when the structure is being attacked by fire and heat. Also firefighters need to be aware that even after the first impact load of themselves and their equipment or their moving loads as they work on the roof may not only cause a partial collapse in their immediate area but also cause progressive collapse to other portions of the structure.

Floors and roofs are designed with allowable factors accounting for live loads. These loads vary according to the structures function or use as well as their location geographically. For example residential structures having engineered systems such as I-joist on average are designed to carry live loads from 50 to 60 pounds per square foot where as public buildings can increase their designed live load capacities up to 100 pounds per square foot. Some commercial structures such as factories can have a designed live load factor of up to 200 pounds per square foot. Roofs on the other hand are usually designed to support their own weight along with any additional permanent features such as HVAC systems, bulk head enclosures, skylights, solar systems and many more accommodations. Engineered roof systems also account for live loads such as snow, rain and wind depending on the area of the country the structure is built. It is estimated that many engineered truss and roof systems are figured on average for dead loads between 9-16 pounds per square foot with live loads for wind, rain and snow up to 35 pounds per square foot. If we look at these basic numbers we can easily see that floors can hold more and roofs a lot less and that reveals the answers to us when it comes to just one firefighter in full PPE and SCBA while not to mention the tools and

equipment he may be carrying. His impact load alone could be in excess of 230 pounds in a square foot area he is standing. Now add his working impact load and you can readily begin to see the potential for collapse caused by his presence and his actions in structural firefighting. All the engineered truss systems and their configurations for dead loads and live loads mentioned do not involve these same engineered systems being exposed to fire and high heat; which should mean to firefighters providing ventilation operations that all bets are off regarding their potential for collapse.

Many engineered roof systems composed of truss configurations in lightweight construction basically consist of 2x4 wood studs for walls and in some cases even used in roof truss construction, 2x8 wood rafters with a ridge board with plywood decking or OSB applied for their covering. Firefighters providing roof ventilation operations are moving about on the roof while walking, kneeling and straddling certain areas at any given time. Their postures and physical positioning on the roof are distributing and shifting their weight continuously which is also shifting the pounds per square feet to any one given area of the roof. It is estimated that a firefighter's posture on a roof is distributing from 70 to 150 pounds per square feet at any given time. This does not include the additional impact load of striking or pounding with a tool or the weight of the tools. Without any impingement present from fire or heat conditions the roof and its engineered systems will handle these loads because the roof decking and its connection points to the rafters can distribute these areas of overload across a larger area. When fire and heat are exposing the rafters or trusses and firefighters are concentrating their work in one area on the roof the combined weight of their presence and equipment along with the striking and pulling actions of their tools does not distribute the load enough under fire conditions which are weakening the wood members.

Horizontal Ventilation

Horizontal ventilation practices at structural fires are another method of venting fire and smoke. It carries with it though a stricter and accurate assessment of the fires true location within a structure in order to avoid bringing fire and heat into unwanted areas that would overcome firefighters attacking fire or searching in other areas of the structure. It also can unknowingly bring fire and heat onto savable victims. This type of ventilation is based upon the fires location while making an opening via windows or doors from the exterior as close to the seat of the fire as possible. In order to determine this it requires an accurate assessment of the fires location and its possibility of travel through the structure to the intended ventilation opening. Taking out windows or doors from the opposite side of a fires location can be disastrous for interior crews advancing lines as well as those crews searching for victims. Proper horizontal ventilation is creating these openings within or right next to the fires location. This creates a proper opening ahead of advancing hose lines allowing fire, heat and products of combustion

to be forced out of the structure when extinguishment is being performed. It also helps the advancement of the attacking hose line. The importance of good communication when these practices are used is essential. Communications between commanders, outside vent crews and interior companies attacking and searching cannot be over stated. The reason for this is to negate any possibility of attack crews, search crews and victims being placed between the fire being drawn to the ventilation opening and an exit path that would be compromised. Coordination and ensuring that hose lines are charged and the advancing crew gets to the fire in a timely manner before the ventilation opening that was created causes the fire to grow affecting other portions of the structure and contents and possibly overcoming the hose lines capabilities in putting it out. Additional if ventilation openings are created or placed in the wrong areas while interior crews are advancing fire and heat can get behind them as well as above them unknowingly. Simply put ventilating to soon or in the wrong areas may allow the fire to increase in size and velocity.

The basics of horizontal ventilation and its applications are done through several different methods such hydraulic, natural air flow of ambient air, positive pressure and negative pressure. These applications have their own tactical and strategic uses at structural fires which are dependent on the fire behavior and location that is contained or self venting upon arrival. The main ventilation tactic used by firefighters for horizontal ventilation is the breaking of windows and opening of doors. These actions create positive pressure and negative pressure throughout the structure without the use of mechanical positive pressure ventilation (PPV). What are troublesome throughout the fire service are how many departments and their members decide to perform this without regard for what the effect will be on interior firefighting and civilian safety. It is important to establish operating guidelines based on the fire dynamic at any given incident and what is to be accomplished or attained. Extinguishment of fire and occupant survivability as well as their rescues may very well hang in the balance when the decision to horizontally ventilate is used. Fire department personnel should train on the variables and their decision making process when applying horizontal ventilation as well as facilitating actual techniques on opening and clearing windows. The success in the use of horizontal ventilation is dependent upon precision, coordination and communication. The tactical decision process then is the action of venting or as an alternative anti-venting. Either approach or its intended purpose is to gain a tactical advantage in extinguishing the fire. With this being said firefighters and their commanders must weigh the effects of horizontal ventilation and even roof ventilation for that matter which may affect Rapid Fire Progress (RFP).

Actions That May Lead to Rapid Fire Progress or Spread: Untimed vent openings, Inappropriate geographical vent openings, Creating vent openings without a charged primary attack line, Delay in fire attack.

Actions Taken To Counter or Prevent Rapid Fire Progress or Spread: Proper initial door entries, Confirming the fire room or origin, Applying water on the fire quickly, Applying water into hot gases at ceiling levels quickly, Coordinated ventilation, Anti-ventilation to isolate fire (closing doors and windows).

Primary Decision Actions Prior To Ventilating: What is the purpose, Direction of wind and its influence, Fire location and Fire conditions.

Critical Decision Actions Prior To Ventilating: Where are the victims or occupants, Where is the primary attack line located, Where are other interior firefighters located.

Decision Strategy For Anti- Ventilation: Fires indicating flashover or backdraft, Hose lines not in position to attack the fire, Spreading fire into roof areas.

Horizontal Ventilation and Wind

When horizontal ventilation is performed another concern is the affect that wind in its direction and velocity will affect the fire and a crew's ability in putting it out. Wind driven fires are extremely difficult to advance on due to the increase of the fires intensity and velocity pushing fire and heat down on the advancing hose line endangering its crew. Wind causes rapid and unpredictable changes in fire conditions in varying results when involved in structures as low as a one story ranch up to extreme fire behavior in multi stories and high rise structures. In many cases it is logical to assume that horizontal ventilation many times is the only alternative in structures exceeding certain heights with limited or time consuming roof access for placing vertical ventilation. In residential structures where interior fires have broken through causing window failures with high winds present created a flow path of fire from the upwind side of the structure all the way through the home to the downwind side of the structure at the opening of the front door. Any advancing hose line and its members operating the line can be confronted with rapidly escalating floor to ceiling temperatures from the wind driven flow path of the fire while on the interior jeopardizing their safety. Wind driven fires and the fire flow paths along with their intensity have even burned through hose lines. Wind driven fires at residential structure fires need to be taken seriously and solid tactical decision making should provide for the safety and effectiveness of operations of firefighters and possible victims. Applying water from the exterior into the upwind side of the structure may be the only option before attempting interior operations. Using the wind as a tactical advantage in gaining control of the fire by attacking from the upwind side in some cases may require pushing fire into unburned areas before being able to apply an offensive attack from the other direction. Many times the offensive attack is the exterior upwind direction along with any life rescue that can be attained in the high intensity fires produced by wind.

When fire self ventilation or firefighter ventilation has occurred with moderate to high winds present a known room and contents fire can turn into a fast moving fire storm throughout the structure particularly in high rise type structures. Firefighters in multi dwellings with numerous floors and high rise structures are forced to fight fires from the interior. When these fires are wind driven the conditions can be become untenable which has resulted in many firefighter injuries and fatalities. Many fire departments have not fully recognized the impact of wind driven fires and as a result have not provide or addressed actions in their standard operating guidelines in implementing proper courses of action to handle these hazardous conditions. Simply recognizing and including wind conditions in size-ups upon arrival before beginning fire attack as well as during fire attack can help attain a constant adjustment to wind conditions throughout the operation.

Based on what we know about wind driven fires through analysis studies, fireground experiences and firefighter injuries and deaths we need to adjust our tactics when our size-up reveals this threat at structure fires. This will enhance and help guarantee the safety and effectiveness in our operations. Many times applying water from the exterior from an upwind point of ventilation will have a significant impact in controlling fires within these structures and then if feasible commit to interior operations. By using the wind to our advantage we can acquire better control especially if fire is present on the burn side of the structure with the wind blowing into it. Many would argue that applying hard hitting streams from the burning side would impact the rest of the structure possibly causing more involvement throughout the building, but the presence of strong winds is already pushing flames and hot gases in a flow path throughout the interior. Winds create extreme thermal conditions from just a simple room and content fire and a flow path to and through any other exterior opening that may be present downwind from the seat of the fire. It has been well documented that even a simple room and content fire in a single story ranch that is wind driven will generate a flow path that is untenable for firefighters to advance lines as well negating any possibility of survivable occupants let alone their rescue. The more stories or floors we add to the scenario the more difficult it becomes to control and apply our tactics at wind driven fires. Also the higher we go the more likely the wind may gain velocity and strength. Part of our tactics at higher floor wind driven fires should possibly incorporate the use of Wind Control Devices (WCD). When these units are deployed these devices can be very effective in reducing the wind velocity into the structure or a particular floor or area. It can also help in decreasing the intensity of thermal conditions in the fires flow path towards the downwind side of the structure. These devices look similar to large canvasses or blankets that are designed to be deployed by at least 2 firefighters because of their size and weight. Their purpose is to block the wind when they are placed over windows or doors. Departments should look into WCD’S in controlling wind driven fires especially if the presence of multi story structures are within their jurisdiction.

Preparedness for Wind Driven Fires

- **Training our actions and influences at different types of structures.**
- **Training on tactical deployment issues, points of entry and openings throughout the structure in controlling wind and fire flow path.**
- **Training on sectoring multi-story structures while confining and controlling wind driven fires.**
- **The use of water application, WCD's, existing protection systems within structures, construction features and layouts at structural fires.**
- **Understanding impact of our actions regarding PPV, Water, WCD's**
- **Establish SOG's for wind driven fires regarding firefighter safety, fireground operations and the use of equipment.**

Positive Pressure Ventilation (PPV) In Structural Firefighting

Positive pressure ventilation and its use in structural firefighting have created quite a debate in the American fire service. The use of PPV as a viable strategy in offensive interior firefighting should be incorporated with extreme caution in our tactical decision making process at structure fires. In order to consider the use of PPV as a tactical strategy in offensive firefighting it must be studied regarding its pros and cons before incorporating it into any standard operating guideline for your department. What are we considering in its use? Is PVV being used as an offensive tool or attack tool? Are we trying to decrease fire gasses such as carbon monoxide (CO)? Is PPV being applied before or after water application? Will PPV create a safer environment for firefighters as well as civilians? Are we using PPV to enhance visibility in structures? These are the many considerations that must be thoroughly addressed regarding its use. At structure fires the use of PPV falls under a decision tree of 3 areas; no PPV use, PPV prior to fire attack and PPV used post fire attack. Positive Pressure Ventilation is in essence a controlled type of a wind driven fire but accurately directed away from the opposite end of a fire while aimed at the fire in as a direct path as possible with an adequate ventilation opening placed horizontally ahead of the fire to allow heat and smoke to be forced out of the structure. We have 3 ventilation techniques for the fireground, vertical ventilation, horizontal ventilation and positive pressure ventilation. When we decide to use PPV for offensive interior firefighting we are using it in an attack mode along with an advancing hose line. Timing is crucial. For lack of a better term for this approach to offensive interior firefighting we will use the term Positive Pressure Attack. Many departments throughout the UK and Europe have been engaging in this maneuver with great success but also with explicit knowledgeable training in its use to its members.

The American fire service is fast moving into applying this technique and maneuver as well but much slower on being completely sold on its concepts due to several injuries and deaths at structural fires and training fires because of improper application methods. Many departments in America still need to do their homework in perfecting and getting the theory down correctly in its uses.

If your department plans on incorporating positive pressure attack at structural fires then training for positive pressure attack will have to be experienced in fire training towers or acquired structures with live fire in order to understand and experience its capabilities. In general we are talking about some basic elements when using positive pressure attack.

Basic Elements of Positive Pressure Attack

- **Firefighters must make sure the natural winds and the positive pressure fan is at their backs.**
- **That a proper size ventilation opening is provided downwind opposite the fan and preferably is made just ahead of the seat of the fire or in the area or main body of fire.**
- **That proper pressurization of the structure ahead of the attack line is established and maintained.**
- **That positive pressure fans are of the correct size and their placement whether at doors or windows are properly positioned regarding their conical spread at the openings.**
- **Any thick smoke or flame emanating from the top of door or window from which the positive pressure fan is operating has been place either incorrectly or is not producing enough positive pressure to clear the environment ahead of an advancing line.**

The above mention elements are just some basic concepts in the use of positive pressure attack. It cannot be emphasized enough that unless thorough hands on training with proper size fans is acquired that it would better off left on the rig before attempting this method for the first time at a structural fire. There are some departments so well trained in positive pressure attack that they are able to control and extinguish fires within an environment that advancing hose lines have not only complete visibility but also an environment of way less exposure to heat conditions. Depending on the level of training in using positive pressure ventilation and attack fire extinguishment can be made safer and more tenable with increased visibility in all types of structures.

Deterrent Factors In Using Positive Pressure Attack

- **Not Trained In Its Use**
- **Unknown Location Of Seated Fire**
- **Unable To Provide Proper Downwind Vent Opening In Size and Location**
- **Improper Size Powered Fans**
- **Interior Firefighting Already In Progress**
- **Fire In Walls Or Attic Spaces That Have Not Been Thoroughly Exposed**
- **Interior Searches Already In Progress**
- **Attack Hose Line and Back Up Lines Not Established Or Failed Water Supply**

Knowing the basic principles of the use of positive pressure entails placing proper size fans producing proper power and so configured in front the opening of the intended advance of the attack to create a strong consistent presence of positive pressure within the structure. This along with properly sized and placed ventilation openings to allow the fire flow path and its contents of smoke and heat to exit the structure ahead of the attacking hose line and its members. It is very important that the powered fan's capabilities are recognized and that the delivery and force of positive pressure is measured by the amount of air it can transport and push throughout the structure. Members must be aware that PPV acts differently at any given structure or building and its effectiveness may vary depending on a structures configuration or floor plan layout. It also important to mention that natural wind directions and crosswinds can affect the fans ability to overcome pushing these winds which may counter the effect of the fans ability in establishing strong positive pressure within the structure.

Besides the use of PPV for positive pressure attack there is another survival mindset for the well being of our firefighters in reducing the hazards during fire operations and that is during overhaul. It has be well documented that short term exposures to fire gases still emanating after fire extinguishment will result in long term health issues for firefighters that are not properly maintaining SCBA support during overhaul operations. The use of PPV helps clear these gases and contaminants from these operational areas within the interior after full control have been achieved in the fires extinguishment. As firefighters perform overhaul pockets of fire within walls, framing and voids are inevitably discovered creating constant off gassing within the confined areas along with the areas of previous fire involvement. In this day and age of firefighting many departments are establishing specific operating guidelines in monitoring the off gassing conditions

through metering in parts per million (ppm) in determining when a firefighter is allowed to remove his air mask while working during overhaul. To help save time while keeping firefighter exposure during the overhaul phase to a minimum when looking for fire extension is the use of thermal imaging which is of great assistance.