The Non-negotiables

1 Introduction

In January 2017, the International Fire Instructor's Workshop was held for the tenth time. This year the group gathered in Hong Kong to exchange new ideas. One of the presentations elaborated on the model *strategy – tactics – technique* which was described in the previous article. The Australian John McDonough talked about the different tactical choices that have to be made on the fire ground. He pleaded for a modern way of fighting fire where there is room for thinking out of the box, while at the same time stating that there are a number of things that should be happening at every interior attack. He calls these things the non-negotiables, that which is not up for debate.

2 Interior fire fighting

Over the past 15 years, ideas on interior firefighting have changed radically. The men and women who have joined the fire service in that period, have been taught a lot of these things during their basic training. That cannot be said of the people who have been around for a longer time. For them, an awful lot has changed and that process of change is continuing.

Aside from firefighting, firemen have to keep up with new developments in fields such as vehicle extrication, hazmat operations, traffic safety measures, … It is understandable that some people can no longer see the wood for the trees. It is up to the fire training schools and their instructors to explain matters clearly enough so that the important things stick. Fire training schools have to be ambitious enough in that respect. They have to spread new insights even when they know that the implementation of these new developments is not for tomorrow.

Some new developments offer small advantages and make certain things easier. Other developments are genuine crucial improvements. These are the kind that make fighting fires safer and more efficient. Fires in buildings with small compartments such as housing, apartments, hotels, retirement homes, smaller offices, … happen fairly often. For such fires there is a recipe which can be followed most of the time. This is not the case with fires in large gyms, movie theatres, industrial buildings, … In those situations, out of the box thinking will be required.

In standard situations there are certain things that are not optional. A crew executing an interior attack in a house, office, … should always be performing the following things:

1. Stay low
2. Control the flow path
3. Cool the gases
4. Put water on the fire as quickly as possible
5. Use the Thermal Imaging Camera (TIC)

3 The non-negotiables

3.1 Stay low

In the past, firefighters were taught to enter a burning building whilst standing up. After all, the training course on personal protective equipment (BA) used a standing advancement method. Such techniques are jokingly called the *BA salsa* or *firefighting kung fu* abroad. Advancing through a room filled with smoke while standing up, has a large number of disadvantages to it. It is better to stay low. Staying low is defined by keeping at least one knee on the floor at all times.

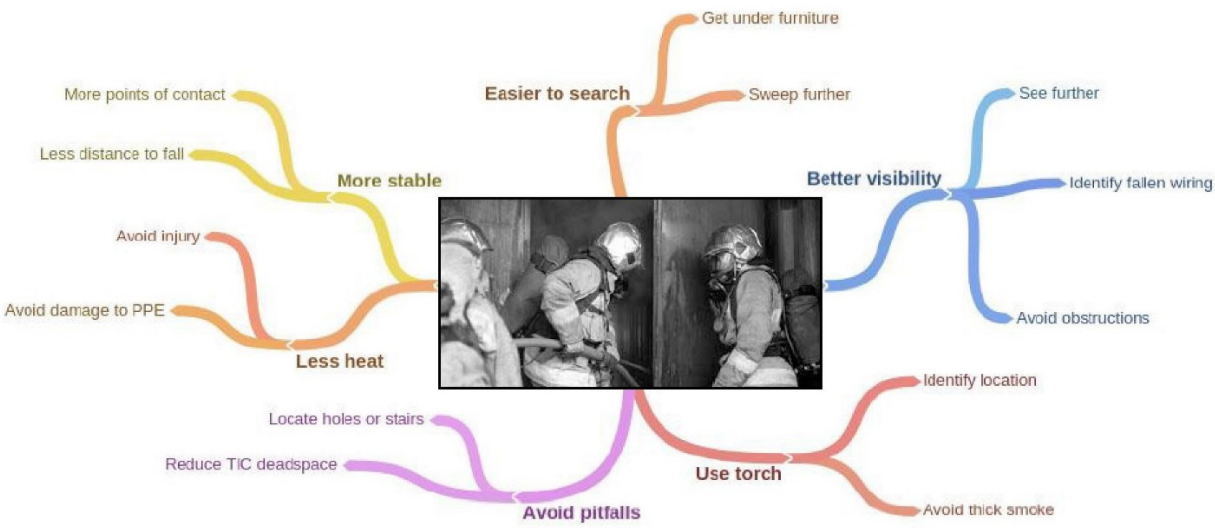

Figure 1 All kinds of arguments for staying low to the floor during interior firefighting. *(Figure: John McDonough)*

The transition from a standing up position to a low one while advancing on the fire, was first introduced in the earliest forms of interior firefighting training. It was justly stated that the temperature inside the smoke layer is considerably higher than below it. Therefor a fire attack crew has to stay as low as possible to absorb a minimum amount of energy and thus heat themselves up as little as possible. Some colleagues argue that often it is not yet too hot when they enter a building and so they can remain afoot in the smoke. They ignore the fact that at some point it can become too hot. At that point they will be forced onto their knees by the heat. When that happens, they have to ask themselves whether they can still continue the interior attack. Their turnout gear will have absorbed much more heat than that of the crew that stayed low.

A second reason for staying low to the ground during an interior fire attack is visibility. The temperature is lower beneath the smoke layer as opposed to in it. Visibility is also better underneath the smoke layer. Even when the entire room is filled with smoke, there will be (slightly) better visibility at the bottom. Down there, the smoke is often less thick so a flashlight used close to the floor will yield a better result. Also, because the smoke is less thick there, it will be easier to spot flames quickly than up in the smoke. Finally, a little bit of visibility down below will offer some insight into the layout of the room. Where is the furniture? Which way is the quickest for the attack crew to advance? This insight will be far more difficult to gather when standing up.

Victims are most likely to be found on the floor or close thereby (e.g. in a bed or on a couch). Rarely will victims be found at one and a half meters upwards from the floor. A crew standing up is simply searching for victims with their hands at the wrong height. Close to the ground, this will go a lot more efficiently. It is easier to feel in a bed or a couch. A crew that is staying low, is at the correct height for this. It is also easier to search underneath objects (like a table). Again, this is harder to do while standing up. When staying low, the chance that a crew goes by a victim without noticing it, becomes smaller. Of course, a proper search technique has to be used. By fanning the legs out in wide circles, it becomes easy to quickly search a large area for any victims.

There is also a blind spot when using a thermal imaging camera. Anything that is close to the floor, directly in front of the firefighter, cannot be seen on the screen. The higher the TIC is being held, the bigger the blind spot becomes. So, this is another reason for staying low to the ground.

During a typical standing progression, there was a "supporting leg" and a "feeling leg". The feeling leg was used to probe the area of the floor directly in front before moving the supporting leg forward. This was done to avoid falling through a hole in the floor. By staying low, the center of gravity of a firefighter is located much lower. The distance to the floor is far less when compared to standing up. This reduces the risk of stepping into a hole with your foot, losing balance and falling forwards into a hole or stairs. In Belgium, it is rare altogether that a fire crew falls through a hole or that a floor caves in. The rise of lightweight construction (see previous article) could cause this risk to increase.

While standing up, there are only two points of contact with the floor: the two feet. A firefighter that is staying low usually has the complete lower part of one leg and a foot in contact with the floor. That way, he or she is in a much more stable position. When a firefighter has to advance and handle a nozzle at the same time, he or she also has to deal with several reaction forces. It is not easy to manage these while standing up in a zero-visibility environment. Close to the floor, this will be easier. If a firefighter were to lose his or her balance, the consequences of a fall will be less severe when already close to the floor. The firefighter would simply roll over or could post a hand and maintain their position. When losing balance in a standing position, the firefighter will make a full fall which is something to avoid in a smoke-filled environment.

3.2 Control the flow path

Over the past years, attention has shifted increasingly towards controlling the flow path during a fire. In North America, this is more important than in Belgium. After all, it has long been a standard practice to break windows in order to achieve horizontal ventilation. At a fuel controlled fire, this will lead to the removal of smoke without making the fire grow at the same time. In the past, most of the fires were fuel controlled when the fire service arrived on scene. Fires developed a lot slower back then. Nowadays, fires progress very quickly. When there is sufficient ventilation, flashover will occur within two to four minutes. Most of the time, there will not be enough air. When the house is closed, the fire will become ventilation controlled before flashover. This is called an under ventilated fire development. When windows are broken or vented at such a fire, the heat release rate will increase swiftly and (ventilation induced) flashover will occur.

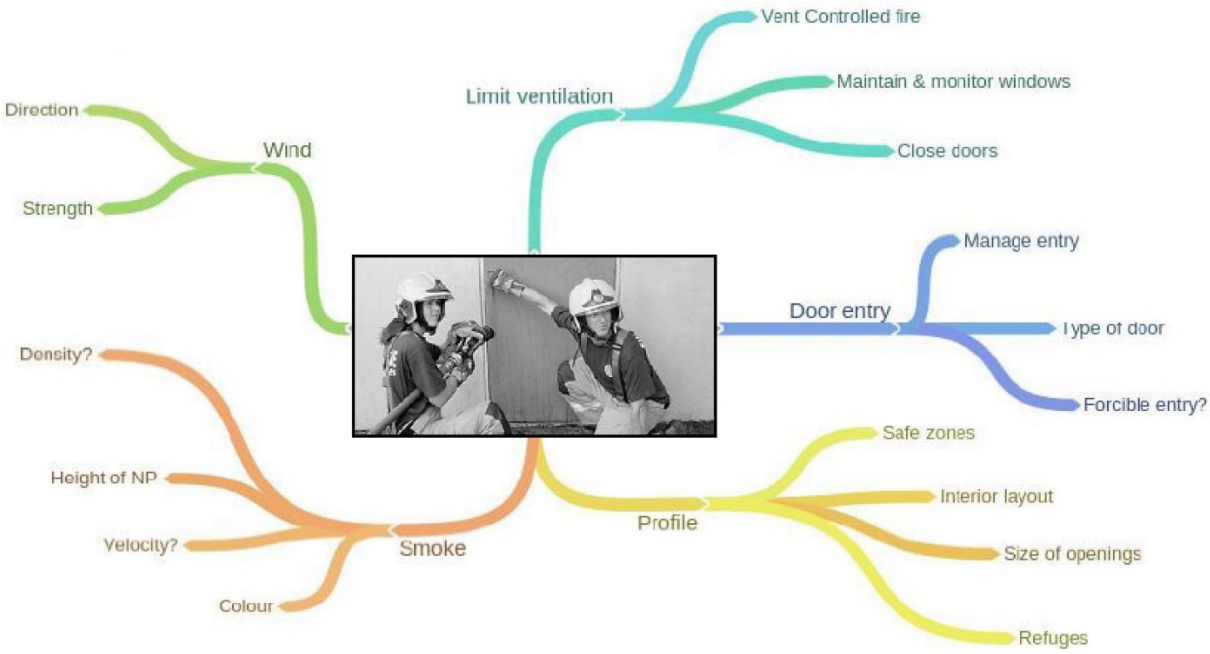

Figure 2 Different reasons why the flow path should be controlled by fire crews. *(Figure: John McDonough)*

In Europe, windows are very seldom broken on purpose but the understanding that opening a door is equal to venting, has spread among the fire service. A door is after all, just as much an opening through which air can flow into the building. In modern firefighting, it is important that the flow path is being controlled at all times. This can be done by positioning someone at the door. That person will keep the door as closed as possible. He or she will also feed the hose line into the building so that the door does not become a troublesome friction point. If the door is the only opening, the door man will subsequently be restricting the intensity of the fire as well. If the door is 90 cm wide and is completely open, it will burn ten times harder than when the door would be manually restricted to a 9 cm opening. An opening that is ten times larger, means ten times more air will get in. This means the fire will burn ten times as hard.

The introduction of the door man is still in its infancy in Belgium. The Belgian fire service typically operates with duo's. Often the two duo's in the back of an engine are still divided into an attack crew and a water supply crew. This is an outdated method of operation. The first two man crew is still the attack crew most of the time, but the second two man crew should be deployed according to the situation.

Figure 3 A firefighter executing the function of a *door* man. He is keeping the door as closed as possible while feeding the hose line into the room.. *(Photo: Ed Hartin)*

In a modern fire service where vehicles arrive on scene from different fire stations, an engine officer could opt to deploy an entire engine (two duo's) for the attack line. He can assign three firefighters for advancing the hose line while a fourth stays at the door to control the flow path. This means that the second duo is split up. The engine officer could also opt to help himself with the hose line, closely behind the attack crew. Then, the line is being advanced by five people. This will lead to a much faster deployment and advancement of the attack line. Since fire progresses at a very rapid pace nowadays, this can be considered a large benefit. It is important however, that the engine officer maintains radio contact with the engine driver outside so he or she can come back out for a short briefing when the command vehicle or second engine arrives on scene.

There is another way for managing the flow path. German fire officer Michael Reick invented the smoke stopper to this purpose. This simple device blocks the opening of the door using a kind of fire blanket. It can be put in place in the door opening by a single firefighter. In case of an inward opening door, this can even be done before the door is opened. Well trained firefighters can accomplish this task even in a smoke-filled room using only touch. The smoke stopper causes the flow of smoke, and thus hot gases, to stop altogether. It will protect neighboring rooms from the effects of the fire. The smoke stopper also does a better job at this than the door man. A door man always has some small part of the door open through which smoke can get out. Aside from stopping the exiting smoke, the smoke stopper also blocks the larger part of the inward air flow. Only at the bottom of the door, a little bit of air will flow in. The fire service of Antwerp is a progressive organization in Belgium and has added the smoke stopper to their engines. The fire service of Brussels has also started using the device and more will undoubtedly follow in the near future. A large benefit of the smoke stopper is that crews are kept free for other tasks. An engine officer could easily choose to take two duo's up into an apartment fire. The second duo can install the smoke stopper at the apartment door. After the first duo has started the attack on the fire, the second duo can perform search and rescue.

Figure 4 The crew has put a smoke stopper in place at this fire. This restricts the outward flow of smoke gas into the hallway. As soon as the attack crew passes the door, the curtain falls back into place almost completely blocking the flow. This creates extra protection for the inhabitants of the rest of the building. *(Photo: Lukas Derkits / Fire Department Wiener Neudorf, Austria)*

An additional benefit of controlling the flow path is that the velocity of the smoke flowing through the building, is being limited. Typically, at under ventilated fires, the smoke layer will be very close to the floor. This means that firefighters will be operating in that smoke layer. Heat will be transferred from the smoke layer onto the firefighters. The faster this happens, the shorter the time will be that they are able to work in this environment. When their turnout gear becomes completely saturated with heat, they will be forced to come outside to avoid getting burnt. The rate at which heat is transferred from the smoke layer onto the firefighter increases as the temperature of smoke rises. However, the heat transfer also increases when the velocity of the smoke flow is higher. Restricting the flow speed of the smoke layer can offer a significant advantage for the fire crew.

In any event, controlling the flow path means that there needs to be a good door entry procedure. Fortunately, the door entry procedure has become a well-known method of operation in Belgium for some time now. Even though the official standard door entry procedure could use some refining touches, the Belgium fire service has already made significant progress there.

Forcible entry, the techniques associated with opening a closed and locked door, is something that could use further attention though. Naturally when a door is forced open, the flow path needs to be controlled as well. This can be done by using a webbing sling. Attaching a sling to the door allows the firefighter to pull the door back after it has been forced open. By doing this, the fire crew avoids being unable to close the door when it pops out of its lock. Afterwards the sling can be used to control the flow path at the door opening. Another possibility is that the door is held almost completely closed until the smoke stopper is put in place.

3.3 Cool the smoke gases

Gas cooling made its introduction into the Belgian fire service in the early 2000's under the name "3D technique". Step by step it became clear to everyone that crews needed to pay attention to cooling the smoke gases during an interior fire attack. The question is not "should I gas cool?", the question is "how much should I gas cool?".

What are the consequences of gas cooling when it is not necessary? Well, a little bit of water will fall back onto the floor and there will be some water droplets hanging on the ceiling and walls. Because of the damage caused by the smoke, these rooms will need to be repainted anyway. Unnecessary gas cooling therefor does not have any real downsides to it.

What are the consequences of not cooling the smoke gases when it definitely should be done? In those cases, rollover could occur in the smoke layer leading the room to flashover and the attack crew inside may perish. So, there are major consequences to not gas cooling when it is needed.

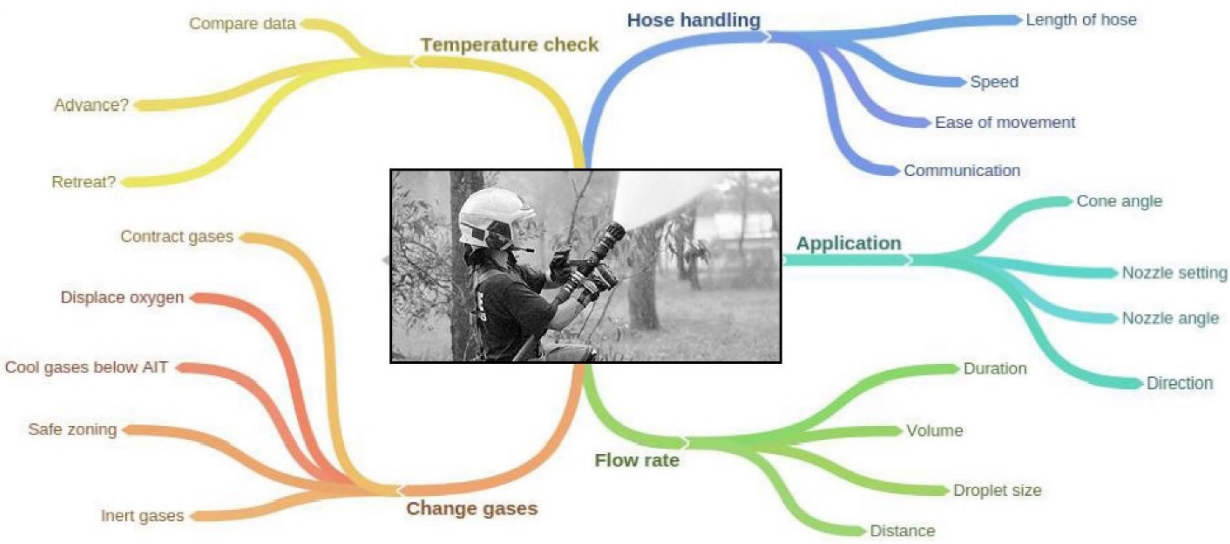

Figure 5 Cooling the smoke gases is very important. *(figure: John McDonough)*

It is important to pay sufficient attention to smoke gas cooling. In reality, this is best achieved by using long pulses. The cone of the water spray is set around 30 to 40°. The nozzle is cracked open for about two to three seconds. The direction of the nozzle can be upwards or a bit more angled down for reach, depending on where the smoke gases need to be cooled. It is important that firefighters have an idea of how far and how high they can get their water droplets. This determines the area that can be cooled.

Figure 6 The long pulse is the appropriate way of cooling smoke gases. *(Figure: Geert Vandamme)*

The flow rate at the nozzle does not have to be that high. A flow rate of 200 liters per minute is enough for cooling the gases. It is important however to have a good quality nozzle capable of producing fine water droplets. And to achieve these droplets, there needs to be a high enough water pressure in the hose line. Modern nozzles often require six to seven bar water pressure at the nozzle. When the crew is operating on a (dry) riser, this can be a problem.

The principle of gas cooling to lower the temperature of the gases. Hence the name. A smoke layer with a lower temperature means less heat transfer (through radiation and convection). This will lead to a safer environment inside. Flashover will be slowed down by this. The water droplets will convert into steam. This alters the mixture of the smoke layer. The smoke layer becomes less flammable. This reduces the chance of rollover. Finally, the flow speed of the smoke layer is lowered as well. Normally, there is a strong flow in the smoke layer from the fire outwards. By gas cooling, that flow is being briefly halted after which it starts again. As stated earlier, the convective heat transfer is reduced when the flow speed of the smoke decreases.

When the temperature of the smoke layer drops, its volume is also reduced. The decrease in volume is compensated however by the expansion of water turning into steam. Because of this expansion, it is important to use a low flow rate at the nozzle. Higher flow rates will lead to too many droplets shooting through the smoke layer and vaporizing on the ceiling and walls. The walls and ceiling will be cooled, but they will not shrink. The expansion of water turning into steam will not be compensated by a reduced volume of smoke gas. This will cause turbulence and can lead to thermal inversion. The hot smoke layer will be pushed down by the steam onto the floor where the firefighters are located.

Finally, gas cooling offers some information on the temperature of the smoke layer as well. When the water vaporizes inside the smoke layer, a hissing sound can be heard. That sound can be used to assess how warm it is above the fire crew. Gas cooling is therefor also a kind of temperature check.

3.4 Put water on the fire as quickly as possible.

In large parts of the world, the interior fire attack has been the standard method of operation for some time now. Since the introduction of the breathing apparatus it has become possible to enter a smoke-filled room, go searching for the fire and put it out.

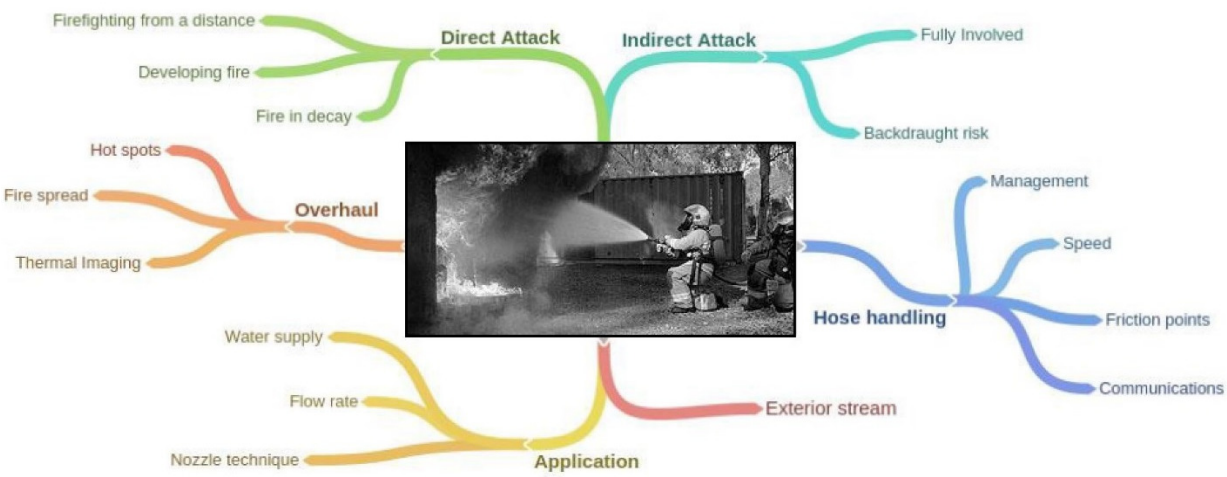

Figure 7 Extinguishing the fire can be done using several different ways. The quicker it is done, the better. *(figure: John McDonough)*

This method was deemed superior to that used before it: flowing water in from the outside until the fire stops burning. The old method meant that sometimes tens of thousands of liters of water were flowed in through the windows. The goal was to drown the fire out

completely. This method was very inefficient and often the damage caused by the water far exceeded the fire damage.

About forty years ago, the transition was made from exterior to interior fire attack. This caused the exterior attack to become somewhat forgotten. In many countries the idea grew that professional firefighting was done on the inside and that the exterior attack was for amateurs.

Research in the US showed that a combination of the two is possible. When the fire can be reached from the outside, it is best to attack from the outside first to lower the heat release rate. There are different names for this in the US: *Hit it hard from the yard, Soften the target, …* Upon arriving, the fire crew will first attempt to knock down the fire from the outside and then perform an interior attack. This tactic is called transitional attack.

3.5 Using the Thermal Imaging Camera (TIC)

In the past 10 years, the TIC has become a standard tool for the fire service. Nowadays, every engine has one or more TIC's on board. Of course, these cameras have to be used and must not remain in the vehicle.

A duo performing an interior attack should take a TIC inside with them. It can be used to search for the seat of the fire. Aside from that it can also be used to look for victims. Finally, a TIC can help evaluate the effectiveness of the nozzle. This means the effectiveness of both the gas cooling and the direct attack on the fire. In both cases, a TIC is a valuable asset.

4 Prerequisites

The implementation of the non-negotiables will not come easy for most organizations. Something like this requires a lot of energy. Several different conditions have to be met so that firefighters will always apply these five standards.

First and foremost, there is the training aspect of the firefighters. If the fire service wants its people to perform their jobs well, then it will have to provide decent education and training. This relates to theory, "cold" training drills and live fire training. It is important the firefighters understand their workplace. Next, they have to train different abilities first in standard training drills and then in a live fire training environment. Only then can we as a society expect that our firefighters will do a good job on the fire ground.

Next, rules have to be made in the fire service regarding these non-negotiables. A simple example could be: *If we are facing a fully developed fire that has vented itself through an easily accessible opening, then transitional attack is our standard method of operation.*

It is important that the five non-negotiables are translated into multiple SOG's which are common in the fire service. SOG's lead to a collective pattern of expectations on how the crew will conduct their business once they arrive. It is important that firefighters, engine officers and chief officers are all on the same page here.

Finally, an important responsibility rests with the crew officers and chief officers. They have to make sure that firefighters also apply the intended method of operation on the fire ground. During training everyone is told what is expected of them. On the fire ground, commanding officers need to make sure that everyone carries out what is expected of them. This can only be achieved when sufficient time and attention is allocated to this topic in the fire station. All officers have to perform an exemplary role at all times, in both the attitude and the methods of operation they expect from the group.

5 Words of thanks

This article is based on the ideas of John McDonough. John is an Australian fire officer leading around 20 fire stations in the busier part of Sidney. I first met him in Germany in 2009 during a course on 3D Firefighting, named after the book which he co-authored. Since 2009, John has been a mentor, a friend and a continuous source of inspiration. He continues to come up with new ideas and innovating concepts to make firefighting both more efficient and safe. This is the 38th article in this series and without him, this series not would never have been what it is today. I wish to pay homage to John McDonough.

6 Bibliography

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