Direct attack

1 Introduction

In several previous articles we discussed the direct attack. Simply put, this comes down to the following: direct attack is putting water onto the fuel. The goal is to lower the surface temperature of the fuel. All solid fuels will start producing pyrolysis gases at a certain temperature. These gases feed the fire. If the surface temperature of the fuel drops below that temperature threshold, pyrolysis stops. That way, the fire is extinguished.

This specific method of extinguishment can be applied in many different ways. The situation with which the fire crews are confronted, will determine the best way to apply a direct attack.

2 Penciling

Penciling was introduced in Belgium in the second half of the 2000's. In Wallonia it was taught by Frenchman Pierre-Louis Lamballais. It was quickly picked up in the rest of the country. Since 2010, it has become part of the curriculum in the firefighter training course. The idea behind penciling is that of firefighters performing an interior attack to find and extinguish the seat of the fire. While advancing towards the fire, the crew will continuously perform gas cooling in the smoke. As soon as the seat of the fire is found, a direct attack is started using penciling.

Penciling is just one way of doing a direct attack. Penciling uses small amounts of water. The nozzle is set on a straight jet stream. Next the nozzle is opened slowly. The moment the water hits the fire, the nozzle is closed again. It's important to note that the nozzle has to be opened slowly. A common mistake is to quickly open the nozzle, which causes a high impact of the water stream onto the seat of the fire. This has to be avoided. Another reason why the nozzle needs to be opened slowly is the size of the droplets. When the nozzle is opened slowly, thick droplets are formed.

In a direct attack, droplet size is very important. Droplets that are too small, will not reach the seat of the fire. For this, big, fat droplets are needed. These will fall onto the fuel surface and evaporate. Ideally, the water will slowly run down the burning object. That way, the largest possible surface area is cooled down. This droplet size is very different from that needed for gas cooling. When gas cooling, the nozzle needs to be opened as fast as possible. The higher flow speed of the water creates smaller droplets because the water is flowing through the teeth of the nozzle. When the nozzle is opened more slowly, a lower flow speed is achieved which in turn leads to thicker droplets.

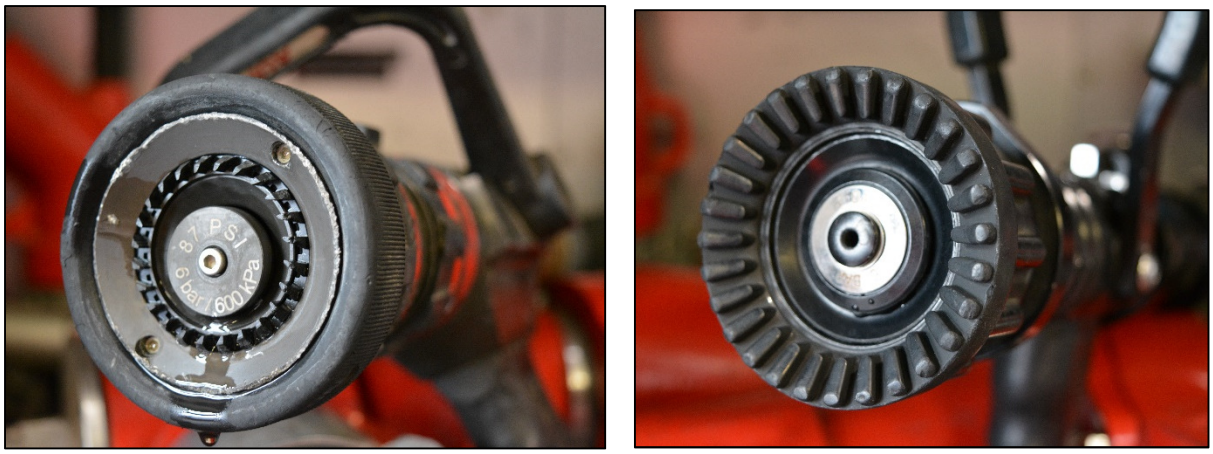

Figure 1 Two different nozzles. The nozzle on the left is equipped with a spinning ring of teeth. The flow of water will cause the ring to spin which in turn creates smaller droplets. The nozzle on the right uses a different mechanism. This nozzle uses fixed teeth on the cone setting. These will also cause droplets to be formed. *(Photo: German Berckmans)*

Penciling means repeating this action until the fire has been knocked down. This technique is ideal for small seats of fire because it uses very little water. Especially at under ventilated fires, crews will often face small seats of fire in a low visibility environment. Any excess steam created by the hose would cause visibility to deteriorate even further. Penciling would be a good idea in that situation.

In the past, penciling was practically always used in conjunction with gas cooling causing the creation of the technique "pulsing-penciling". Penciling is a technique suited for small fires. Because of the discontinuous nature of this technique, the cooling capacity is rather limited. It will take a while before the fire is brought under control. During that time, fire crews also need to control the smoke layer above them. Gas cooling is the best way to achieve this.

3 Painting

Painting was introduced the same way as penciling. It was taught as the next step after pulsing-penciling. The fire attack crew has brought the fire under control and is now advancing toward the seat of the fire to start final extinguishment and overhaul.

The nozzle remains set on straight jet stream. However, the nozzle is opened only slightly to achieve a straight jet stream reaching about one meter. Because of the very low flow speed, thick droplets are formed that will further lower the temperature of the burning fuel.

Australian fire officer John McDonough came up with second way of using painting. He uses painting as an alternative to penciling. Suppose an attack crew starts an interior attack in an apartment with a fire burning in growth stage. During the advance towards the seat of the fire, the crew will cool smoke gases. Long pulses can help to maintain control of the smoke layer in an aggressive way. Now imagine the crew is faced with a big sofa that's largely on fire, after their advance. Penciling would not be suited for extinguishment here. The cooling capacity of penciling is too small for such a fire. Also, such a fire is often close to flashover. It's important to quickly achieve knockdown.

Painting could serve as the solution in this situation. The nozzle is opened slowly once more. The reach of the stream is set so that the water just reaches the sofa in a small arc. That way, thick droplets are formed once again. The nozzle man will not close the nozzle however. He will leave it open and move the stream over the entire surface of the sofa. He will continue until the fire has been knocked down.

It's important to realize that the crew will still need to cool smoke gases. In a way, the term "pulsing-painting" applies. John McDonough chooses a simpler approach and defines these techniques as "direct attack". Fire crews need to choose and adjust the amount of water used for attacking the fire on one hand, and controlling the smoke layer on the other hand.

In the situation described above, the size of the fire is rather small. Painting could however, also be used in case of a fully developed fire. The fire needs to be knocked down using an indirect attack. Next, firefighters need to finish off the fire to prevent it from growing once more. Here, painting plays an important role. Right after knock down, the inside temperature of the room is still very high. The contents inside will continue to pyrolyze. The firefighter that has performed an indirect attack, can now follow up with painting from the same spot to further lower the temperature.

4 Full jet, full flow

The term "full jet" is used to indicate the shape of the water stream. In Belgium, it is also used to define a method in which the full flow rate of the nozzle is used. When the nozzle is fully opened, water will flow through very quickly. Therefore it doesn't matter whether the nozzle is opened up quickly or slowly. After a few seconds, the water reaches its maximum flow speed.

This method is applicable in several different scenarios which can also be categorized as "direct attack".

4.1 Very large fires

Suppose fire crews arrive on scene to find a large stack of wooden pallets burning. The heat release rate of such a fire can easily become very high. Protecting exposures will probably be one of the primary concerns for the fire service. Painting would be a good way to deal with the fire if it was only one stack of maybe 10 pallets. The radiant heat will be limited and the fire will quickly diminish in size as soon as the direct attack is started.

Figure 2 Even a fire monitor can be used to perform a direct attack. *(Photo: Warre Saint-Germain)*

However, when there are several stacks of pallets next to each other, the radiant heat will be much higher. It will not be possible for the crews to move close enough to apply water in an arc onto the fire. Aside from that, this type of fire

needs a bigger cooling capacity than can be achieved with painting.

In this situation it is advisable to open the nozzle completely. This will lead to greater reach of the stream, as well as a higher flow rate. For very large fires, this form of direct attack is to be used. Fire monitors flowing water onto stacks of pallets are performing a direct attack, even if the flow rate exceeds 4000 liters per minute.

4.2 Transitional attack/Exterior attack

Suppose you were to arrive at a fully developed fire that has self-vented. If the openings through which the fire has vented itself can be reached, the fire can be knocked down using an indirect attack. It will often be the case though, that these openings cannot be reached with the fog pattern of an indirect attack. Maybe the fire has vented through the window on the 3rd floor. In that case, a "full jet" can be a way to perform a direct attack.

Figure 3 Fully developed fire on the ground floor. This fire can be tackled using an indirect attack. Suppose the fire is located on the first floor or higher, a short exterior attack with a full jet against the ceiling may then offer the solution. *(Photo: Nico Speleers)*

It will not be possible to flow water onto the burning combustibles from the ground level. The only way to do that is up high from a ladder truck. However, this will require some time to deploy and to set up its water supply. It is possible to flow water against the ceiling of a 3rd floor compartment from the ground. This can very quickly be done by connecting a single hose line of Ø 45 mm or Ø 70 mm directly to the pump of the engine and start an exterior attack. Using a high pressure booster line is not recommended because more often than not, the limited flow rate of the high pressure line will not be enough to knock the fire down. Eventually, the high pressure line will have to be flowed continuously for a longer time, meaning that more water will have used be to achieve knockdown.

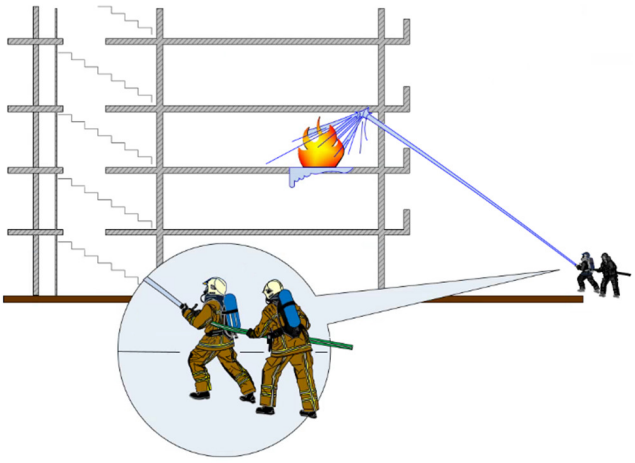

Figure 4 Exterior attack as the first part of a transitional attack. Water is flowed for about 10-15 seconds with a full jet (sufficient flow rate) up against the ceiling to achieve knockdown of the fire. *(Drawing: Bart Noyens)*

The water that is directed against the ceiling, will ricochet and fall onto the floor. There, part of the water will fall onto the burning contents of the room. Of course this isn't as efficient as flowing water directly onto burning fuel, but it is still an effective method. Since the goal is still lowering the temperature of the fuel load, this

method is also categorized as a direct attack.

This type of exterior attack is part of the tactic called "transitional attack". In this tactic, an exterior attack is first executed using a full jet. It's important to note that this is done for only a small amount of time. The full jet only needs to be flowed in for about 5 to 15 seconds. The goal is to knock the fire down. The second part of the transitional attack consists of a classic interior attack. The goal is not to keep flowing water in from the outside for over 30 minutes.

Perhaps we could come to some general agreements in the fire service on this matter. An exterior attack using a full jet is probably the best way for dealing with a fully developed fire that's located above the ground floor, provided that the stream can reach the opening. This should be part of a standard operating procedure for these kinds of fires.

For fully developed fires located on the 1st to 4th floor, a hose line of Ø 45 mm can be used connected directly to the engine pump with a reducer. If the fire's on the 5th to 7th floor, a hose line of Ø 70 mm will be needed. The reach of the Ø 70 mm will be higher. The larger hose line could also be used for the first 4 floors. The downside is, it will require more people to man. If the Ø 70 mm is used for a fire on the 6th floor, the reaction force on the nozzle will be very large. Several firefighters will be needed to man the line. This means that the crew won't be able to deploy the interior attack line, until after the fire's been knocked down. If a 45 mm hose line were to be used, one 2 man crew could start deployment while the other 2 man crew performs the exterior attack. This situation will result in a faster and more efficient fire ground operation.

Figure 5 Fully developed fire venting from the back of a building. *(Photo: nufoto.nl)*

For fully developed fires on the 8th floor or higher, a fire monitor mounted onto a ladder truck can be used. Of course this will take longer to set up than a hand line which is operated from the ground. On the other side, it will also take much longer for an attack crew to advance to floor below the fire and set up an interior attack from there. It will be very important to coordinate both crews (attack and ladder).

4.3 Interior attack

Imagine arriving on scene at an apartment fire. It's a large building and the fire is venting from the back. Because of the size of the building or the limited access to the surrounding area, it's not possible to start an exterior attack. The window through which the fire is venting for instance, is located right above the ground floor in which a parking lot is situated. The solution then would be to start a classic interior attack.

The attack crew will start the attack from the stair case. As soon as they open the door to the apartment, smoke will flow into the stair case. The firefighters will use gas cooling while advancing the line. If the fire in the living room is fully developed, the smoke flowing into the hallway leading up to that living room, will be very hot. There will probably be some flames rolling into the hallway as well. The attack crew needs to cool the smoke gas aggressively. By using long pulses, they will be able to advance down the hall.

However, it's possible that at some point the crew will have to halt their advance because it's too hot. At that time, they may not yet have reached a position from which they can perform an indirect attack. The indirect attack could be ideal for bringing this fire under control. Alternatively, a full jet can be directed through the door and up against the ceiling. Part of the water will ricochet and fall on top of the burning fuel. This may lower the heat release rate of the fire. The outward flow of hot smoke gas will decrease, which allows the attack crew to advance once more.

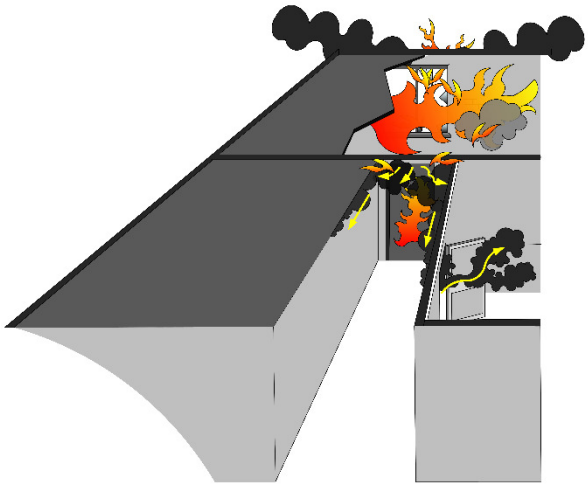

Figure 6 Fully developed fire venting from the back of a building. The fire crew will have to attack the fire from the hallway. *(Drawing: Bart Noyens)*

Again, this is a form of direct attack that can be used if the situation calls for it. And again, this form of direct attack will most likely fail when using a high pressure booster line.

5 Closing remarks

This article has extensively covered the different ways of performing a direct attack during fire ground operations. There are techniques that use very little water (penciling), a bit more water (painting) or a lot of water (full jet). It's up to firefighters on the fire ground to choose the appropriate technique for the job. It's up to the fire service as an organization to create expectations in a way that it's clear to fire crews which actions are expected of them.

During firefighting, it's possible to shift from one technique to another if the fire conditions demand for it. Also, different techniques may be used simultaneously or one after the other.

Eventually this article can be summarized in the following saying:

"How much water? As much as needed!"

6 Bibliography

[1] *Training course "3D firefighting", John McDonough, Ed Hartin & Karel Lambert, PIVO September 2015*

[2] *From Knowledge To Practice, training project of the fire service of Canada, 2014-2015*

[3] *John McDonough, personal talks, 2009-2015*

[4] *Ed Hartin, personal talks, 2010-2015*

[5] *Etienne Semence, personal talks, 2014-2015*

[6] *Course Formateur Flashover, IPF Hainaut, October 2008*

Karel Lambert