Teaching nozzle techniques

How and why the focus has shifted from 'technique' to 'goal'

1 History

The fire service puts out fires. It has been doing so for a very long time. Before there were actual fire departments, fires were put out by civilians. They formed long lines between a river or a pond and the fire. Buckets of water were passed up the line and thrown on to the fire as best as could be achieved.

This was not an efficient way of extinguishing fires. Soon after, pumps were invented that could flow water in a certain direction using pressure. These first pumps were stationed in a container with water. The pump directed the water into a fixed nozzle. The reach of the water coming from the nozzle was determined by the pressure being built up. This meant that the pump needed to be close enough to the fire. After all, the nozzle was fixed in place onto the pump in a 45° angle. People had to keep the container filled with water at all times. This was done using buckets. So in fact it was only a minor improvement of the "water line".

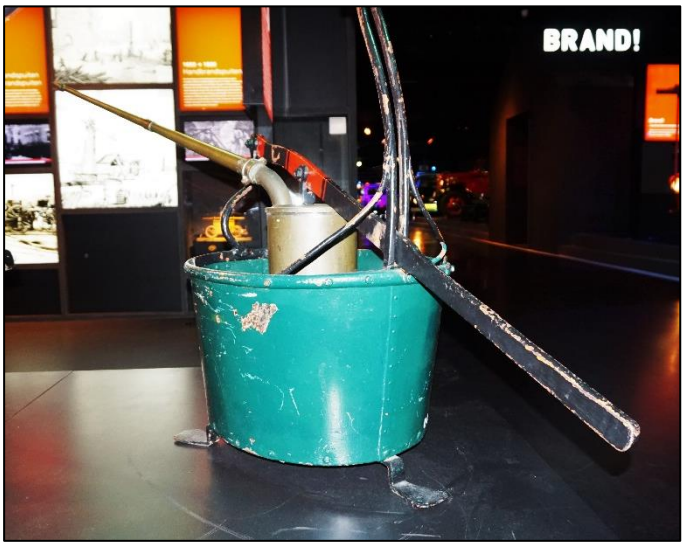


figure 1 The first "fire pumps" had a fixed nozzle that could not change direction. *(Photo: Firefighting Museum Hellevoetsluis The Netherlands)*

The real big improvement came in 1672 when Dutchman Jan van der Heyden invented the fire pump. He combined a pump with hoses. There were two kinds of hoses: suction lines and discharge lines. Because of the suction lines, the pump had to be placed close to an open water source. Next, the discharge lines transported the water towards the fire. This made the line of people with buckets obsolete. On top of that, the nozzle at the end of the discharge line could be moved around. This caused the beginning of the first interior attacks.

Over the past centuries, fire pumps have been improved substantially. Nozzles have also been improved upon. The first nozzles could only form a solid jet stream. During those first few centuries, nozzle design has remained pretty much the same. At first, there wasn't even a valve to shut off the water flow. Then, ball valves were added so that the nozzle operator could open and close the flow of water.

In Belgium, this resulted in the "standardized" nozzles of 45 and 70 mm. These nozzles had a tip which could be screwed off. Without the tip, the exit diameter of the nozzle increased which doubled the flow rate. These nozzles were still broadly being used in Belgium during the early 2000's. The solid jet stream had a very far reach.

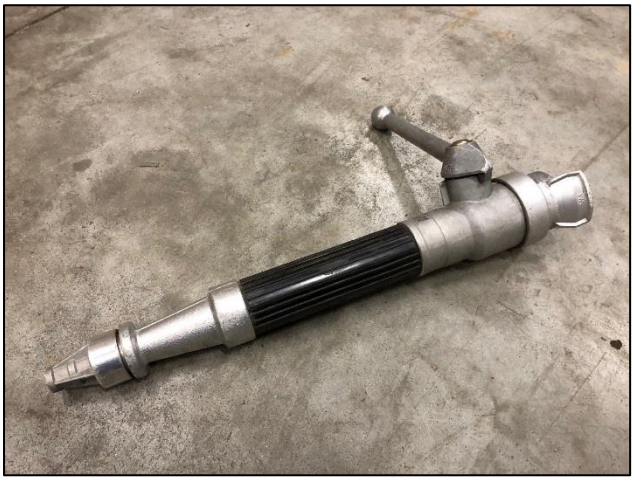


figure 2 The "standardized" nozzle *(Photo: Warre St-Germain)*

In the US, these types of nozzles remain popular today, though the design has been modernized. They are called *smooth bore* nozzles. They are characterized by the solid jet stream of water that is being formed.

Over the past decades, more and more modern nozzles were introduced that, aside from a solid jet stream, could also form a spray or fog pattern. These types of nozzles are called *combination nozzles* or *fog nozzles*. The straight stream coming from such a nozzle is not really a solid jet anymore, but the reach of the straight stream is still relatively far. A lot of people feel that a solid stream from a smooth bore nozzle can be used to accomplish certain things, which cannot be done with a straight stream. This is why smooth bore nozzles are still standard in some parts of the US.

The introduction of the fog nozzle however caused the creation of several different nozzle techniques.

2 Why nozzle techniques?

Why do we even have different nozzle techniques? Why does a firefighter need the flow water in different shapes and forms? The main forms are:

- The straight or solid jet stream
- The fog pattern
- The water shield

These different forms each have their own application. The main advantage of the straight stream is reach. On top of that, the water droplets are all packed tightly together. A large amount of water can be thrown in one single spot. This is an advantage when having to put out a solid object that is on fire. However if you have to cool smoke, this becomes a disadvantage. When cooling smoke, you want your water droplets to be spread out over a large volume.

The fog pattern is better suited for cooling smoke. An important parameter is the angle of the water cone. The large this angle becomes, the wider the water fog becomes, but the less far the water is flowed forward. Within the category of "fog pattern", the angle of the water cone can vary.

The water shield is primarily used in industrial firefighting. The best known application of this is advancing towards a flaming gas leak to close a valve, while using the protection of a water shield.

Thus firefighters have several nozzle techniques so that they can use water differently according to the needs of the situation. This allows them to act more efficiently. Nowadays, a lot more can be achieved with far less water as opposed to the days of the buckets.

3 Naming

When modern nozzle techniques were first introduced, several different names were thought up for them as well. After all, it had to be called something. Each of the pioneers has tried to come up with a good and catchy name for the new techniques because a good and catchy name sticks and adds to the learning effect.

In Belgium, the term **3D technique** was used first. This is now called the **short pulse**. Later the **long pulse** was added. The 3D technique ushered in gas cooling in Belgium and the Netherlands. It took several years however for firefighters to realize that the 3D technique was not a replacement for a straight stream. Gas cooling cannot be used to extinguish fires. This message was not given enough importance in the beginning, as was the field of application for the technique. This led to undesirable outcomes where firefighters were trying direct pulses into fully developed fires.

figure 3 Penciling is a technique in which water is flowed in a straight stream towards the seat of the fire. As soon as the water reaches the fire, the nozzle is shut. *(Photo: Christophe Gardin)*

Techniques that also made their way into our fire academies were pulsing-penciling and painting. **Penciling** is a technique for which the nozzle is set to a straight stream. Then water is pulsed which causes small amounts of water to be thrown onto the seat of the fire. This techniques performs extremely well in a fire training container and it helps in learning nozzle control. The downside of this technique is that in real life it really only works on very small fires, beginning fires or small and isolated objects (e.g. desk chair or hoverboard). Again this part of the message was not sufficiently emphasized which led to firefighters penciling a fire that was too big in reality. The fire would keep on burning of course and firefighters would ask themselves why the fire did not behave the same as in the fire training container.

Painting was a technique that was used for final extinguishment and overhaul. After achieving knockdown, the crew would advance further towards the fire. Using a very short straight stream (1 m) the remnants of the seat of the fire were completely but gently overflowed. Later, this name was also used for when a fire was attacked from farther away. Extinguishing from 4 or 5 meters using a straight stream, but without fully opening the nozzle, was also defined as painting. An early name for this technique was *sweeping.*

One of the next techniques to be taught, was known in Flanders (Dutch speaking region of Belgium) as **massive attack**. In France (and French speaking parts of Belgium) it was known as the **ZOT-method**. In North America it is known as **combination attack**. The main area of application for this technique is the fully developed fire. By moving the nozzle

once or twice in an "O" pattern (while flowing a large amount of water), knockdown is achieved in a normal sized room. The effect is instant. It is a very powerful technique that allows for firefighters to gain control of a situation that is rapidly escalating. Other letters are sometimes used as well: a "T" and a "Z", the ∞ symbol, … This technique can also be used as part of a door entry procedure, when the fire is showing signs of backdraft. Using this technique, a very large amount of water, in the form of water droplets, can be mixed into hot smoke gases.

These are all the nozzle techniques currently being instructed in Belgium. There are many more other techniques that are not (or no longer) being taught in fire academies, but that each have their own shape and name. All of these names are well meant, but they make for a very complex and confusing whole. A lot of firefighters no longer see the wood for the trees. On top of that, there is a demand in Flanders to use less English terms. These are considered by some to make matters more complex.

Instructors are searching for ways to impart knowledge as efficiently as possible. After all, training time is a limited resource in firefighter training. Under the guidance of John McDonough from Australia, a thought movement was formed which looks at nozzle techniques from a different perspective. There are 3 types of techniques and techniques are categorized according to their intended goal. Each firefighter holding a nozzle should know what he or she is trying to accomplish. Based on what the intended goal is, we can define three categories of techniques:

- Gas cooling
- Indirect attack
- Direct attack

4 Modern approach to teaching

The new approach to teaching nozzle techniques is primarily focused on the goal of the techniques and the three ways to achieve an intended goal. This means that a lot less – or even none – attention is paid to naming the technique.

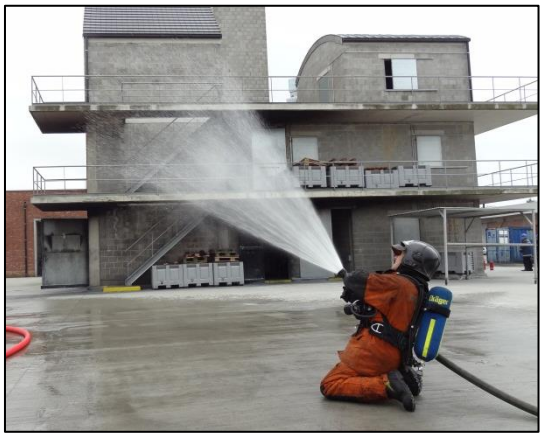
4.1 Gas cooling

The goal of gas cooling is to create a safe working environment for the attack crew to operate in. The smoke layer above (or around) the attack crew signifies an important hazard for them. Cooling the smoke layer and mixing it with nonflammable steam, reduces the risks. This is done by directing pulses into the smoke layer while using a fog pattern.

A lot can be told about gas cooling. The angle of the water cone is of importance, as well as the angle of the water flow in relation to the floor, the flow rate, the time the nozzle valve is opened, the way the nozzle is being held, …

The most important technique in this category is the long pulse. This term means there is also a short pulse. In reality, the nozzle man can do whatever change is needed to achieve

the optimal result. Maybe the amount of time the nozzle remains open is somewhere between short and long…



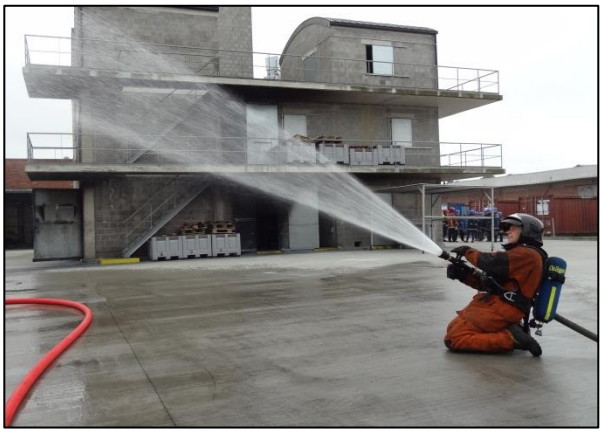


figure 4 and figure 5 The short and long pulse are both techniques to cool smoke. The long pulse will be used most of the time. It can be used to reach further and higher into the room. On top of that, this technique will be able to cool hotter gases as well. *(Photo's: Geert Vandamme)*

4.2 Direct attack

The goal of a direct attack is to extinguish the fire. This is achieved by lowering the temperature of the fuel package below the pyrolysis threshold. When there are insufficient pyrolysis gases being produced to sustain combustion, the fire will stop. In practice this is done by flowing water onto the seat of the fire. Because of the radiant heat emitted by the flames, it is hard to get close to the fire. Then again, getting close is not necessary. Using a straight stream allows for extinguishing from a safer distance.

Flowing water onto the seat of the fire in order to put it out by lowering the fuel temperature, is called direct attack.

Depending on the size of the fire, either a lot or very little water can be used. The water can be flowed continuously, or the crew can use 'pulses' of water. The nozzle can be opened partially or fully. All of these techniques fall into the category of direct attack. The focus is now put on modifying the technique to suit the fire you are facing. A small kitchen cabinet that is burning will be dealt with differently than a large three seater sofa engulfed in flames.

4.3 Indirect attack

The goal of the indirect attack is to knock down a fully developed fire or – in the case of a pre backdraft situation – inert the smoke. In both cases this is done by withdrawing energy from the gases in the room. In a fully developed fire these are flames. Flames are no more than burning smoke gases. Drawing energy from these gases will result in a temperature drop. Aside from that, steam is formed because the water from the nozzle will evaporate in the hot gases and on hot surfaces (walls and ceiling). This large amount of steam forms a thermal ballast and will render the mixture of smoke and air nonflammable.

An indirect attack works best by introducing a large quantity of water droplets into the hot gases. The best way to do this is by "drawing an O" in the room. The O pattern will cause

water to be flowed almost everywhere in the room. Part of the water will end up on the fuel load and will have a "direct" effect there. This effect is negligible in relation to the effect of the water cooling and evaporating in the hot gases. Because of this, the name *indirect attack* was chosen where before this was called a combination attack (combination of direct and indirect). A secondary benefit of the O pattern is that this specific movement is easy to make, even with high reactionary forces coming from the nozzle.

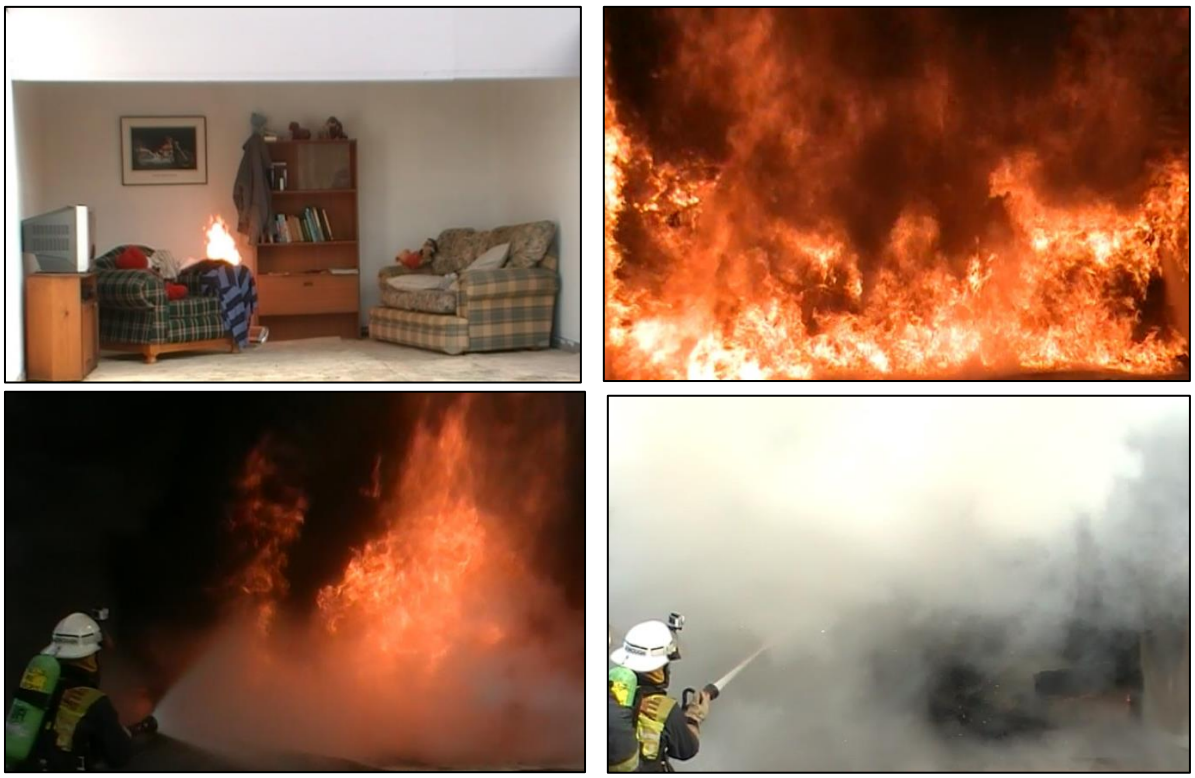


figure 6 The development of a beginning fire (upper left) to fully developed (upper right). Next the fully developed fire is knocked down using an indirect attack. That indirect attack can be seen in the bottom left image. After knockdown, the firefighter has to switch to a direct attack to fully extinguish the fire. *(Photo: New South Wales Fire & Rescue Service)*

4.4 Results

What have been the results of this new approach in teaching? Generally people find it much easier. Even if some people find it hard to let go of all the different names, for the majority of firefighters it is simpler to ask themselves what the intended goal is.

- Do I want to make a room filled with smoke safer? ➔ Gas cooling
- Do I want to knock down the fully developed fire? ➔ Indirect attack
- Do I want to put out the fire ➔ Direct attack

A special reference is made on pre backdraft situations. In these cases, indirect attack is also used.

All of the details regarding the different nozzle settings are modified depending on what the intended goal is.

"How much water? As much as needed!

In earlier days, instructors told firefighters in great detail how they had to perform different techniques (such as penciling and painting). At the end of the course, the firefighters could execute the techniques perfectly. What they could not do however, was adapting a technique to a real life situation: holding the nozzle open for just a bit longer, raising the nozzle a bit, …

The idea is that in the future, more emphasis is put onto the basic principles (gas cooling, indirect & direct). Firefighters in training are still being taught what a fog pattern and a solid jet stream are, but the focus will shift towards adapting to the situation. The question should always be: "What am I trying to achieve?" After applying the technique, the question should become: "Have I achieved my intended goal?" If not (completely), the question then becomes: "What do I have to change to get a better result?"

This way we get firefighters that are efficient with their water. They will act faster and more decisively and will be able, with the same nozzle as before, to tackle larger fires.

5 Refresher course on nozzle techniques

The new approach to teaching nozzle techniques is slowly gaining ground in the fire academies. New generations of firefighters will be trained this way. But what about the active firefighters? How will they get this training? The quickest way to achieve this is by training at the fire station. Usually these training drills are conducted by company officers.

Therefor it is crucial that crew officers are up to speed on the newest developments. They need to be able to ask questions and discuss these topics, so that they can help spread the knowledge. This is how the fire service as an organization can implement change swiftly.

A refresher course should be made available for people that fulfill the role of instructor in their respective fire stations. That way they can pass on the new topics and developments in firefighter training to those who are already active in the fire service. This will lead to new firefighters joining veteran crews that all speak the same language. At present, that is not always the case.

6 Bibliography

[1] *Brandspuit, nl.wikipedia.org*
[2] *John McDonough, personal talks, 2009-2018*