

# Construction Fire In Brussels: Smoldering fire of polyurethane

## 1 Introduction

On January 21th 2009, the Diksmuide Fire Department (Belgium) was dispatched to a fire call in a domestic building. It was a call like any other but almost became fatal for two firefighters.

The Fire Department was sent to a detached one-family-building (Image 1). All rooms in the building were situated at ground floor level. On top, there was an unused attic space underneath a pitched roof.

The building was renovated before. A new roof (structure + covering) was placed on top of the existing roof.

At this moment, new construction works were executed. In the attic, isolation in polyurethane (PUR) was sprayed between the rafters of the structure of the second roof. By isolating the attic in a better way, the house would consume less energy. Spraying PUR is an exotherm process. The construction workers have to respect a set of rules to ensure the heat, which releases with the formation of PUR, is being extracted. During these works, a small fire started. The workers were able to extinguish it themselves. However, they did not contact the Fire Department to check if their extinguishing was effective.



**Image 1** Detached building with living rooms at ground floor level and unused attic space underneath the rooftop. (Picture: JVK)

Some hours later, they noticed a fire odor again. Although they did not see anything likewise, they did alert the Fire Department this time. Access to the attic took place by an attic hatch and attic stairs. The commanders of the fire department climb up and put their heads in the attic hole. They see nothing indicating a fire but decide to send two firefighters up the attic in complete protective equipment, SCBA included.

The two firefighters enter the attic by the foreseen stairs and start their search for a seat of fire. At first instance, they moved to the place the workers were performing. However, nothing was found there. Actually, not any sign of fire was to be seen on the attic. There was no smoke at all.

The attic is a non-usable space. A network of wooden rafters supports the roof. This causes only a narrow space to pass through. This sure is detrimental for persons carrying SCBA, who cannot easily pass through tight spaces.



**Image 2** The wooden support structure on the attic. The space between the rafters was rather limited. Because of this, the liberty of moving for the firefighters carrying SCBA was limited as well. (Picture: Diksmuide Fire Department)

They decide to search the other end of the attic. Therefore, they need to pass the stair hole and proceed in the direction of the other end of the roof.

Until that moment, not a sign is detected of any occurring problem. There is no visible smoke, nor heat. The attic seems to be filled with ambient air.

All of the sudden, the firefighters are surprised by a greenish smoke. The visibility is quickly reduced to zero. They realize immediately they are in big trouble and turn back in the

direction of the stair hole. The smoke ignites and they are now in an attic completely filled with flames. Both firefighters are now in mortal danger. Luckily, they succeed in throwing themselves down through the stair hole.

Both firefighters suffer severe burn injuries. Their protective clothing and SCBA is very heavily damaged. There is no doubt that they survived this because of their professional attitude: Without their breathing apparatus masks, they would not have stood a chance.

Outside, they are taken care of by their colleagues. They receive first aid on scene and are urgently transferred to a burn care center in which they both are treated for a long period of time.

The fast evolution of this fire was a surprise for the fire department in 2009. Nobody understood how this could happen. Apparently, smoldering PUR can change a room seemingly filled with ambient air into an inferno within the blink of an eye.



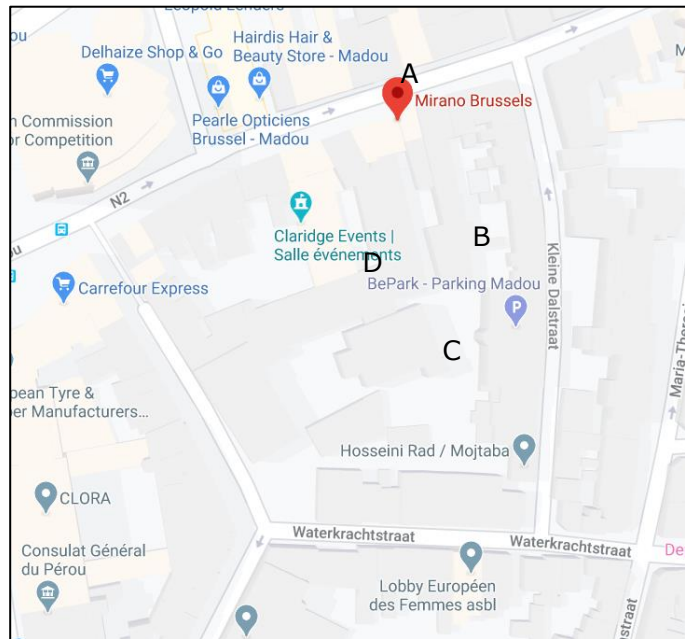
**Image 3** The protective clothing of one of the firefighters after the fire. (Picture: Diksmuide Fire Department)



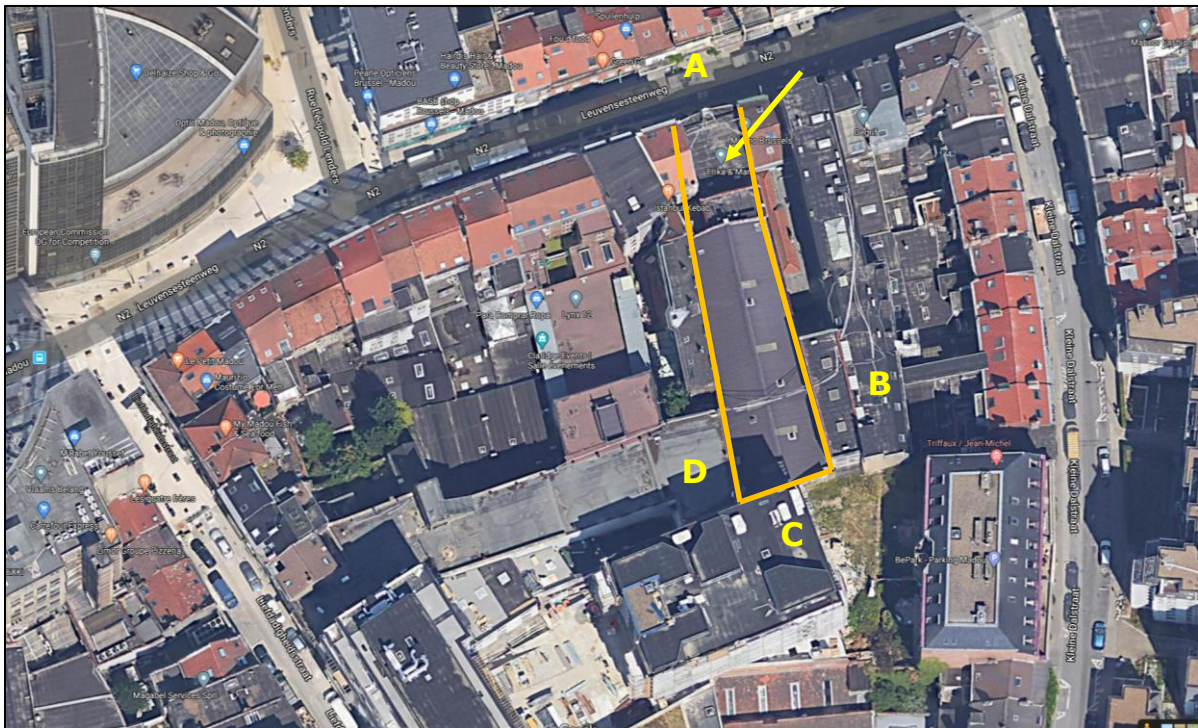
## 2 Call for suspicious smoke in Brussels

On 18th of February 2020 around 14h20, the Brussels Fire Department (DBDMH=Service for Fire and Urgent Medical Aid) is dispatched to the Leuvensesteenweg in Sint-Joost-Ten-Noode for a smoke development. This is a small municipality within the Brussels district with an extremely high population density. The number of inhabitants is 24.000/km<sup>2</sup> (against 376 inhabitants/km<sup>2</sup> in Belgium).

This means that all buildings are standing close to each other. In the other parts of Belgium, houses are often at streetside and the courtyards are used as gardens. In Brussels, a lot of building are situated in second row. This means the courtyards are also filled with buildings, storage hangars and in this case an apartment building. As a result, they are often not accessible for firetrucks. This was also the case in this particular incident.



**Image 4** The Leuvensesteenweg is at the upper part of the picture from left to right. The *Mirano* is indicated with the red needle. (source: google maps)



**Image 5** Aerial picture of the buildings around the *Mirano*. The yellow arrow indicates the front part of the building. Underneath the yellow arrow, the rectangular roof of the dancing is visible. (Source: google maps)

The engine of the "Cité" fire station is dispatched and arrives at 14h25. They conclude that they arrive in nightclub "Mirano". They only have visual contact with the front of the building (Sector Alfa).

Buildings are built against at both Bravo and Delta-sides. The building is pretty long (about 60 meters.) More or less parallel with the long, common walls of the building, one can find "Kleine Dalstraat" (at bravo-side) and "Liefdadigheidsstraat" (at delta-side).

At Charlie-side, there are no adjacent buildings. There is however a medium-rise apartment building at a distance of about 2 meters from the backside of the "Mirano". Image 4 and image 5 show a view of the complexity of this urban situation

## 2.1 First crew on scene

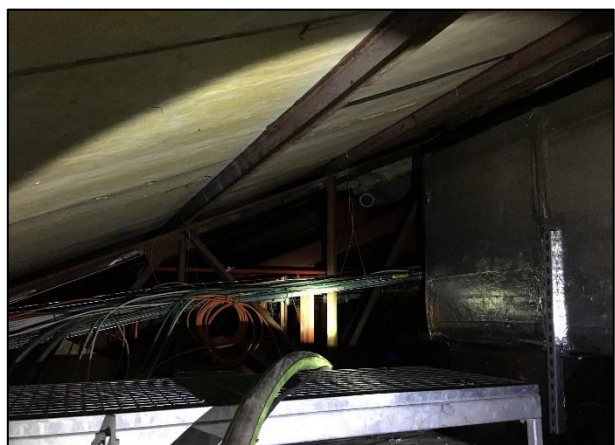
The large hall of the nightclub is situated in the far end of the building. The men of fire station "Cité" start by performing a reconnaissance, led by sergeant Debaucheron. They conclude that workers are executing welding works on a steel ceiling in an attic with technical installations. In this process, something started smoldering. Smoke is coming down from the ceiling. The commander orders a 45mm hose to be coupled and brought to the attic. He correctly estimates that this incident will be more than a simple smoke development and calls for extra units. The rest of the vehicles included in the standard protocol for a structure fire are alerted at 14h37.

In Brussels, an alarm for a structure fire consist of two engines, two ladder trucks, a command vehicle, an ambulance and the Mobile Medical Team (MMT) of the military hospital (if they are available). A ladder truck responds from fire station "Cité", the MMT departs from the military hospital and the rest of the vehicles is dispatched from fire station "Heliport".

## 2.2 Reinforcements

Upon arrival of the reinforcements from Heliport at 14h43, Major Lambert initiates his reconnaissance in his role as a chief officer. The attic above the large hall of the night club is very big (15 meters by 40 meters). The vertical profile of the attic is shaped as a triangle. Metal lattice girders, placed in irregular distances in the attic, provide structural stability. In the middle, one can see a sort of aisle, but is it regularly interrupted with elements of the metal lattice girders, causing obstacles. This causes a very difficult advancing, even with perfect visibility.

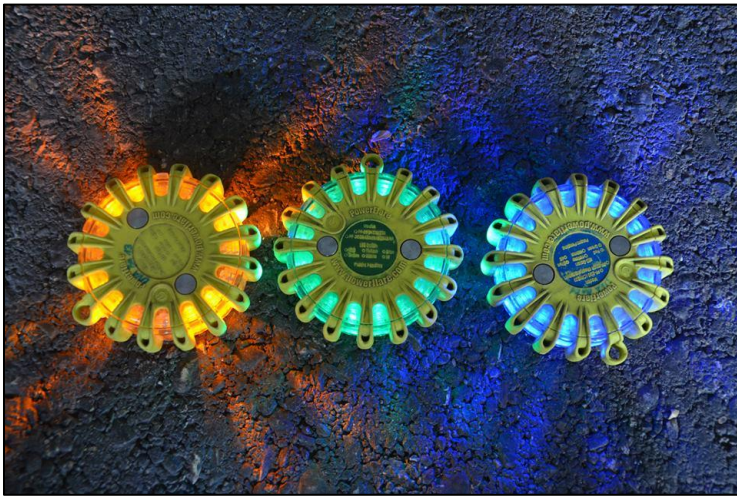
Above all, the entrance to the attic is very limited in space. Two entrance ladders/stairs are used to enter the attic from the floor below. Furthermore, the presence of large ventilation shafts on a specific place on the attic force firefighters



**Image 6** This picture shows the access to the attic. Only 50 cm allow to pass into the attic. For a SCBA-wearer this is a very limited space. (picture: Nicolas Freuville)



to proceed through a very narrow opening to enter or leave the attic.



**Image 7** A yellow, a green and a blue PUC in action. (Picture: Jean-Paul Heyens)

During that first reconnaissance by the chief officer, there is no smoke visible in the attic. He does however immediately confirms the potential danger for firefighters. After all, the situation shows a lot of similarities with the fire in Diksmuide in 2009: A hidden smoldering fire in flammable material in the roof of a difficult accessible attic. He decides to move outside to provide himself a better image of the scene by looking at the attic roof from above.

Meanwhile, the suggestion is made to place green PUC's at the inside which can indicate the way out (conform the recommendation of the learning commission *Beringen*). If suddenly smoke would be produced, firefighters can easily find their way out by following the lights (See image 7). Major Lambert decides around 14h50 to ask for a 3<sup>rd</sup> engine on scene to be sure to have the necessary units if the situation would develop.

The Federal Police Drone Unit was on observing internship with the fire department that day. They came along to the call and had a drone airborne very fast to provide images from above. These images showed the complex structure of the building as visible on image 5. Important in this case is that the gable roof above the attic started only at 20 to 30 meters away from the frontage. It was unreachable for turntable ladder trucks.

The drone images showed clearly that the roofing material was made of profiled steel sheet. There was a fire in the ridge of the roof. This was visible by smoke development and the discoloration of the steel sheet on that location. There were no flames visible. The fire stretched for about one meter. Lightly colored smoke escaped from the roof and thermal images did not show heaps of temperature.

At the inside, firefighters were busy trying to extinguish the fire. They were confronted by the fact the underside of the roof was covered in steel sheet. This made the extinguishing little effective.

A second reconnaissance by Major Lambert pointed out smoke was visible on the attic now. This smoke caused degraded visibility. This made the job even more difficult. The fire department is facing a situation in which they find a fire in the roof, extinguish that fire and seeing it resume itself. The degraded visibility makes it harder and harder to see what is actually happening. The concentration of smoke gasses is rising and at a sudden moment, the lower flammability limit will be reached. Major Lambert lets the firefighters continue but states to proceed with caution. He refers to case Diksmuide, a case which some of the firefighters understood because they knew about it. It became clear by then a hole would have to be made in the roof to evacuate the smoke. He leaves the building

and calls for a second chief officer on scene. As a direct action, Captain De Paepe departs from the main station at 15h12.

Once outside, one noticed there was no possibility to reach the roof from the Leuvensesteenweg. Access to the roof was crucial to be able to make a hole in the roof. The use of an aerial platform was considered. It turned out not to be helpful. Next option would be to use a turntable ladder truck to reach the roof from another street. That was not possible either. Waterkrachtstraat was about 80 meters away from the *Mirano's* rear façade.



**Image 8** The drivers of both command vehicles use the whiteboards for situational awareness and are following radio communications. (Picture: Robert Decock)

In the meantime, the driver of the command vehicle, Corporal Feytens, made a composition with two whiteboards and tried to make an overview of the situation as good as possible. Upon arrival of the second command vehicle, the driver of it joined him. They start to follow up the firefighters carrying SCBA: Who goes in and comes out and at what times. (Visible at image 8).

Major Lambert asks the heavy rescue vehicle on scene to have the gear to open the roof. Gear like a reciprocating saw and a grinding wheel are no basic equipment of an engine. He also asks for the presence of the RISC-team (The Brussels Climbing Team) to secure the actions taken on the roof and search for an entrance to the roof. Last but not least he requests extra breathing apparatus. A lot of them are used on that moment and it is important air tanks can be switched to avoid the interruption of work.

The RISC Team under command of adjutant Vanderweyen starts the search for a possibility to gain access to the roof at 15h21. This seems to be a very difficult task. They continue their goal of the creation of a safe work environment on the roof.

### 2.3 Further Upscaling

At 15h33, the commander of the week, Colonel Van Gyseghem, arrived at the request of Major Lambert. After gathering, he decides to work with the four flanks. Each accessible flank will have a detachment of firefighters led by a chief officer. To make this happen, he decides to scale up further: He orders a fourth engine and an extra chief officer (Major Jalet). The decontamination car and the support car C12 are also requested on scene. The support car is actually a mobile canteen where the personnel can drink or eat something. Colonel Van Gyseghem will work on the situational awareness near the command post. Here he has the schedules on the whiteboards and the drone images at his disposal.

In the meantime, the electricity in the building has been shut off. The technicians from the electricity company have arrived some time earlier. They indicate that there is a high-voltage cabin in the building. It is disconnected at the commands' request. The gas

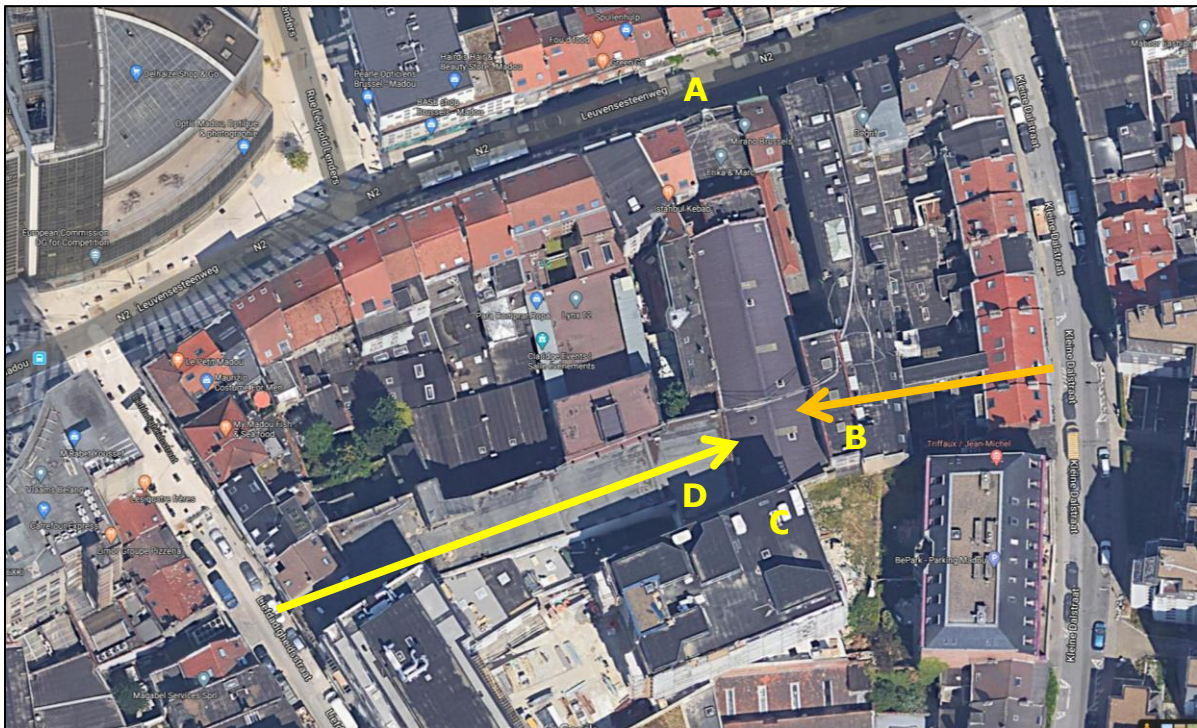


company is also coming on scene. They check whether there is a gas connection in the building and are instructed to shut it off if present.

Maj. Lambert goes back inside to make a third inspection of the attic. At that moment the inside teams decide that the situation has become too dangerous. The attic was completely filled with smoke by then. Visibility had been reduced to almost zero. The non-commissioned officers inside judge that the risk became too high. The smoke can ignite and the difficult accessibility of the attic ensures that the team inside cannot escape quickly. All firefighters in the attic come back outside. As a result, the great risk for the firefighters has been avoided. (Compared to Diksmuide). However, the firefighting comes to a hold because of this. At this moment during the intervention, no one is working anymore on the fire. After all, there is still no way to get to the roof above the attic. This means that there is a risk for this fire to suddenly spread severely. In this highly urbanized environment (see Image 5), this can get out of hand very quickly.

Hereupon Major Lambert calls for another gathering with Colonel Van Gyseghem. The colonel wants to anticipate to an expansion of the fire and decides to divide the scene in three flanks;

- Major Lambert directs the works in the affected building.
- Captain De Paepe takes care of the Delta flank.
- Major Jalet takes care of the Bravo flank.



**Image 9** The Brussels Fire Department finds two entries to the roof of the *Mirano*. Major Jalet finds an acces via a building in Kleine Dalstraat (orange arrow). Captain De Paepe's team finds an acces via Liefdadigheidsstraat. Passing over about 100 meters of flat, connected roofs they reach the roof next to the burning building (yellow arrow). In this way, the fire was surrounded. (Picture: Google Maps)

Both Delta-flank and Bravo flank were assigned an engine. Later in the intervention, the climbing team will divide itself over both flanks.

Major Jalet and his team find an entrance via Kleine Dalstraat. He can get a view of the roof of the attic through an adjacent building on the Bravo side. The fire has spread in the meantime. The ridge is currently burning over a distance of several meters. His team breaks the glass parties in the common wall to gain access to the sloping roof above the *Mirano's* attic. (See Image 11).

Captain De Paepe is able to gain access to the Delta side of the roof via the flat roofs of buildings that reach out onto Liefdadigheidsstraat. They cover a distance of about 100 meters on those flat roofs before they reach the roof of the *Mirano*. Arrangements are made on both sides to ensure that there are two 45mm hoses on either side of the roof ready to begin extinguishing should the fire spread. These fire hoses also serve to protect the facade of the apartment building on the Charlie side. Should the roof of the attic partially collapse and a large fire would start, there would be a potential problem of fire spreading to the apartment building. The two extinguishing hoses therefore also served to cool this facade if necessary.

The teams have now spread over three streets:

- Alpha- side: Leuvensesteenweg
- Bravo- side: Kleine Dalstraat
- Delta- side: Liefdadigheidsstraat

The street at Charlie-side, Waterkrachtstraat, is too far away to be of any use. (See image 4).

The climbing team makes an mounting from the two access points so that a safe working environment is created above the roof. In this way, our people can climb onto the roof in a secure manner.

Col. Van Gyseghem applies the cube concept and asks the necessary preparations to be made to prevent the fire from spreading downwards. There is smoke spread downwards after all. Teams are then deployed to first install light in the large room under the attic. Then two fire hoses of 45 mm are laid from the outside to the main hall so that falling, burning parts can be extinguished.



**Image 10** View at the main hall seen from the entrance. (Picture: Robert Decock)



## 2.4 Technical Solution

Corporal Schepens of the climbing team starts making an opening in the roof around 17h30. This is a very laborious job, under SCBA and hanging from two ropes. The construction of the roof makes this work very difficult. Finally, he manages to make an opening. From that moment on, the fire department has found a good way to fight this fire.

The following hours, the roof is opened further and further. The tactic exists in making trenches to ensure the smoldering fire cannot spread any further.



**Image 11** The climbing team makes an mounting with ropes to secure the works in the roof, followed by the opening of a wall with glass parties to gain easy access to the sloping roof. As a result, the firefighters can start making holes in the roof, hanging by ropes. (Picture: Robert Decock)

As time passes, the hole in the roof is so effective that the smoke can escape the attic. The teams from Alpha-side are activated on that location again. The fire is put under control very fast afterwards. Because of the absence of smoke, the fire is as it were encircled. Visibility has been regained at the attic. The time following is used to work from both the inside as the outside at the same time.

The exterior teams were busy for hours afterwards with making holes in the roof to physically surround the smoldering fire. All this happened while the interior teams kept making holes from the inside to extinguish any fires left. The intervention ended at last at 05h06. It had lasted for almost 15 hours.



**Image 12** As time passed, a trench was realized. On one side of the roof a cut was made along the full length. Because of this, the fire could not move further on that side of the roof. (Picture: Nicolas Freuville)

### 3 Lessons learned

#### 3.1 The value of case studies

The fire department has access to hundreds of case studies. These are most of all foreign case studies but there are some Belgian ones too. A good case study contains a critical look to the fire departments' actions after the facts:

- What was the plan?
- What happened?
- What went wrong? (Not: Who did something wrong?)
- What can be learned? (Not: Who can be punished for it?)

Such documents allow to learn very valuable lessons out of fires that made victims. They offer the possibility to think in complete rest and gain *artificial experience*.

The Diksmuide case learnt us (amongst others) what the dangers of PUR-isolation are and how a situation which appears harmless suddenly can develop into an inferno.

Ricardo Weewer of the dutch fire academy pointed out in the past that cases can lead to a joint vocabulary. It offers the possibility to summarize the complexity of the incident in one word. This allows very fast communication in which a lot of information (about the situation, possible scenarios which can go wrong, actions to take or not to take...) are stated with one keyword.

Recently, a very heavy fire in a high-rise building took place where the spread of smoke had the potential to make a lot of victims. The crewmembers of three engines were used to get the fire under control. This succeeded only after 40 minutes after arrival on scene. Four other engines and two turntable ladder trucks were used for rescues. During the briefing of the second chief officer, the sentence "*We are in Grenfell here!*" was used to explain the situation. A common knowledge of cases can be of a great value.

### 3.2 Fast scaling up

When dealing with a fire with potential of big or fast spreading it is important to scale up quickly. Having the fire department following facts must be avoided at all costs.

During this incident, the sergeant of the first engine made the fast and correct analysis of the situation. His resources (only one engine) were insufficient. Hij immediately scaled up. The first chief officer on scene did exactly the same as soon as he concluded the incident was evolving.

The commander with week duty, colonel Tom Van Gyseghem, scaled up once more. That continuous scaling up had the direct result that enough resources were on scene to master this difficult to reach, dynamic incident in the city center. (See image 9).

### 3.3 Good coordination

Colonel Van Gyseghem started the operational coordination pretty soon after his arrival on scene. There were several impact zones which required attention:

- Smoke spreading
- Expanding fire
- Traffic impact

Especially the deliberation with the police department was important. The incident led to a very important impact on the traffic during the evening rush hour.

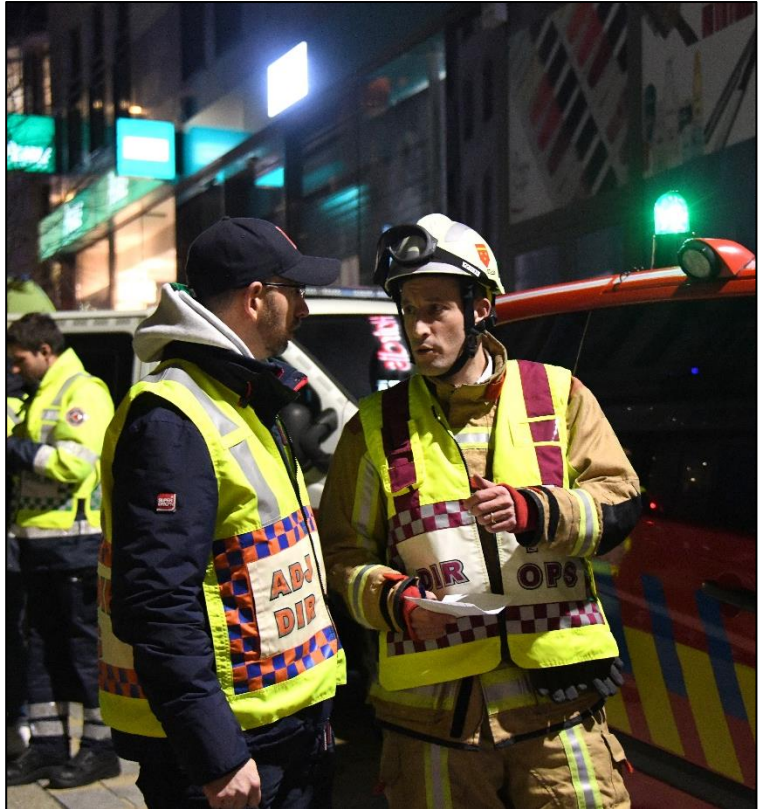
The incident was also divided in several (geographical) sectors. Two sectors (Bravo and Delta) were only separated by the burning roof. The people in those two sectors could communicate by voice with each other. Nevertheless it was a very long distance to get from sector Bravo to sector Delta. In that point of view, the three sectors were geographically far apart. The colonel built a structure for discipline 1: three chief officers which each took a sector for their account. They held consideration together and had a look in each other's sectors from time to time to have a continuous image of the global situation.





All important information was also sent to Colonel Van Gyseghem so he could update his view on the situation and adapt the multidisciplinary aspect to it. The radiocommunication was scaled up too. The flank officers communicated with colonel Van Gyseghem on a coordination channel while, next to that, different channels were used for the RISC-team and the flanks.

Furthermore it was an incident that took a long time. There was deliberation with the local municipality. They assigned a DIR-LOG. The local authority took care of the catering. They assigned a local pizzeria to deliver pizza's to the many emergency workers, including many firefighters, which were active on scene.



**Image 13** Colonel Tom Van Gyseghem with an employee of the local authority. (Picture: Robert Decock)

Coordination between different sectors was established to arrange who was going to eat at what time.

As the intervention continued, the replacement of personnel on scene started. Since the intervention was still going on at full speed, this needed to happen very precise to avoid the escalation of the incident again during the changes.

During the complete intervention, two people paid attention to the firefighters carrying SCBA (see image 8). This is not something that happens standard in Brussels. Neither is it in the most Belgian Fire Departments due to lack of personnel to fulfill this task. Actually, it is something that should happen every time and extra personnel should be requested for this task in case of a complex intervention.

Finally, during the incident, there was a high necessity for coordination with the dispatching of the Brussels Fire Department. The fire at Leuvensesteenweg occupied a lot of equipment and personnel for a long time. There also was a lot of specific equipment on scene. This was all realized without putting the rest of the city coverage at risk.

#### 4 Sources

- [1] *Lambert Karel (2010) Interview about the incident in Diksmuide with Johnny Beernaert and Bart Sansen*
- [2] *Weewer Ricardo, personal communication*
- [3] *DBDMH (2020) Report about the fire at Leuvensesteenweg*

Karel Lambert

