The intervention at the water reprocessing plant of the Parisian Agglomeration Sanitation Interdepartmental Union (in French: SIAAP) in Valenton, in the immediate southeast suburbs of Paris, on September 25, 2009, began as a classic response to a fire or explosion. This included the use of pumps, trucks, ladders and commanding officers.

Little by little, however, the findings suggested that it was an unusual operation, where the risk of an explosion was constantly present due to the presence of both methane (explosive gas), and hydrogen sulfide (toxic gas). Therefore, the need for several officers specializing in hazmat (or technological risks), were essential and a real help to the Emergency Operations Commander (EOC or Incident command manager), particularly in risk assessment, tactical reasoning, resources anticipation, and helping public services and private companies resolve the problem. This intervention lasted three days for emergency services but about a week for the firm working to stop the leak.

What's about?! A classical intervention with great display of trucks.

Having been contacted for assistance, firemen of the , Villeneuve Street, George fire station arrived at 16:00 on the Friday. The sergeant and, chief fireman, accompanied by a site manager, discovered that the building – the outside of which was entirely nondescript and held no key to what happened inside – had been damaged by an explosion, which had destroyed the upper areas, mainly affecting a technical room, where the electrical controls of the whole installation were located. Apart the outer door of this room, which had been thrown over 100 m, (fortunately without hurting anybody), there was no visible sign of damage and no suggestion that an explosion took place.

The chief fireman then sent his team into the building on a reconnaissance, taking with them uncapped breathing apparatuses and hand-held explosimeters (Paris Fire Brigade uses MSA ALTAIR 4s). The team discovered that a further risk of explosion remained, as the explosimeter displayed low explosivity levels (LEL), ranging between 60% and 100%. This was confirmed by the company official, as even though the explosion damaged most of the facilities, only one probe, which was connected to a gas detector of combustible gas, was still working. Thus, results could be read from the outside staircase leading to technical room, displaying equally disturbing values, constantly around the 75% LEL mark.

The NCO immediately requested a "complement of regular start." The starting grid is the emergency response from the Paris Fire Brigade, from common risks to special or major ones; in this grid, the ‘regular start’ (or ‘normal departure’) is the minimum response for a fire or explosion. It consists of two pumps (or one pump and one truck and ladder). The leader of a regular start is called the ‘fire guard chief,’ and becomes the first emergency operations commander (EOC). When the pattern of departure warrants to send a single pump, and the chief fireman concludes that he can’t manage the situation alone, he calls for a ‘complement of regular start,’ thereby notifying the fire guard chief. In the military organization of the Paris Fire Brigade, a fire guard chief may be either an NCO (at least a staff sergeant) or a junior officer. The chief fireman, knew that the site was a water reprocessing plant, but did not know that the building was a SESAME (SESAME, in French: Station Elevatoire de Seine Amont Extension, can be translated as an ‘elevating station of upstream Seine waters’) post. The fire guard chief arrived and learnt that there was a high risk of explosion in the building, but no one was able to say what had caused the initial explosion, or the present explosive atmosphere for that matter. The chief fire guard thus requested reinforcements, seeking the support of a truck (eight firefighters) with its accompanying truck (two firefighters), a Chemical mobile unit (five firefighters), and a Chemical van from the Central Laboratory of the Prefecture of Police.

The intervention turns chemical.

To begin, a quick overview of the support teams: The support truck and its accompanying truck is ultimately a support group dedicated to assist if there is a lack of hydrants in an area of intervention. This group is able to place a two kilometer line of pipes (or two lines of one kilometer), thus bringing water where it is needed. In this case, the only fire hydrant at the plant was unable to supply water to several pumps. In France, a chemical mobile unit generally consists of a single van, but in the Paris Fire Brigade it consists of three vehicles. These are the officer’s car (as the unit head) and two vehicles responsible for responding to chemical hazards. The Central Laboratory of
Back to the intervention – by late afternoon, the situation was far from under control. The company engineers frankly admit that they still don’t have an explanation for the origins of the explosion. They did state, however, that there was a pocket of methane in one area of the building where there it wasn’t meant to be. This causes some confusion. The firefighters and company engineers also measured that the quantities of hydrogen sulfide was larger than the normal amount of production in the average process of sewage treatment in the Paris region. In response to previous requests for reinforcements, the officer of the 17th company arrived at the scene. The Company Guard Officer, a Lieutenant or Captain, is responsible for the operational activity of various fire stations that were spread all over the area of the intervention. Given the complexity of the situation, the persistence of the explosion hazard and the toxic risk, the officer decided to take command of the rescue operation. Within the Paris Fire Brigade, this act of command is official, as it shifts the responsibility to a higher-standing chief. A command post vehicle (Level Fire Group – in the Paris Fire Brigade, this group is the equivalent of a regiment in the Army. Led by a colonel, there are three fire and rescue groups, which each includes eight companies, and three other groups that have functional and non-territorial vocations: an Operational Support Group which includes most of the men and machines of various particular risks (rescue excavation, divers, cynotech, and hazmat); the School Group which brings together all the entities dedicated to initial teaching and professional training; and Supply Groups consisting of all offices and departments that provide administrative and logistic support to the 8,500 Paris firefighters) arrived at the scene, making it available to the Emergency Operations Commander. This consisted of six men and an experienced officer, including a Hazmat & CBRN Brigade technical advisor, informed by the Brigade’s operational center. Due to the nature of the intervention and to the strategic importance of the site for water treatment, the senior group Guard Officer (of the 2nd Fire Group) also arrived on scene and took command of operations, after a precise and complete report of the situation.

The complexity of the situation is primarily due to the complexity of the scene.

Something which may surprise hazmat officers, is the fact that even though the building was a SESAME post, which deals with the upstream part of the rainwaters and wastewaters process, it had never been included in a risk assessment, even though the entire site was ranked as an installation of water treatment, the senior group Guard Officer (of the 2nd Fire Group) also arrived on scene and took command of operations, after a precise and complete report of the situation.

The complexity of the situation is primarily due to the complexity of the scene.

To establish a systemic analysis means defining the triptych ‘source + flow + targets’. The definition of flow is probably the easiest to do, measurements close to 100% of LEL in the upper parts of the SESAME post were discovered over two days; meaning that there was a full range of explosive methane (CH4, which LEL is 5% in air and UEL is 15%) in several parts of the building. The toxic flow was less pronounced although it has crossed the 250 ppm of hydrogen sulfide (H2S, which IDLH value (NIOSH 2003) is 100 ppm). However, there were no more sources of ignition because the electricity, cut off since the first explosion, was not restored.
Strict safety precautions were set for personnel required to perform
reconnaissance. If an explosion were to occur, it could further damage
the concrete structure at the top of the building, spilling concrete; especially
as the expansion cone was mainly vertical due to the
building being below ground. The pressure wave would also be
damned by the high embankment that surrounds the building on
three sides. If we had failed to control the flow of explosives, it would
still be possible to minimize its effects. Obviously, the radius of the
perimeter security had been accordingly sized. The first ‘a priori’
perimeter, immediately fixed by first responders, had been placed 50
meters away from the debris thrown by the first explosion, identified
about more than 200 meters. After the first calculations, hazmat
advisor officers recommend to increase this perimeter up to about 500
meters from the center of the building, and to shelter firefighters
behind walls and other buildings or, failing that, behind the trucks.
Potential targets were also taken into account. The advantage of a
relatively large site, located in an industrial zone, and served by few
roads allowed the police to halt traffic to over a mile around the area,
without any major disruptions to the overall traffic flow. Furthermore,
due to the time and day of week, all the plant workers and operators
were either able to leave immediately or stayed to assist in the
intervention from the management building. The adjacent railways
remained open, as was the connection between the service road and
the main French TGV lines between the north and south of France. The
command post team contacted the rail station to explain the situation
and the risks involved if a certain danger threshold was overstepped,
thereby giving the EOC the power to close the rail traffic if necessary.

A flexible and adaptable manoeuvre.
Even though the EOC was unable to deal with the source of the
problem, he was able, with the help of his advisers, to act on the flow,
and even if he still doesn’t understand it had can begin to operate in
various ways. His idea of manoeuvre can be formulated as follows:

“While continuously monitoring the explosimetry places, I want to
reduce the volume of methane below a threshold of 5% LEL. As a
first step, we need to raise the volume of water, thus reducing the
volume of gas, thereby preventing leakage and adding water flow
through the pipes.

The second step, the main effort, is inserting and filling the whole
headspace with nitrogen.

The third step, if the second step doesn’t work, consists of setting a
hydraulic system with distribution of high-expansion foam, thus
buying the gas volume with the foam.”

The EOC did not set a time framework, as the situation was difficult
to assess, but he did fix a danger limit, which was determined by
experts from the Central Lab as a threshold to end emergency action.
For a good part of the first night, we tried to prevent the water
draining. Divers were engaged in the submerged part of the building,
where they tried to replace and block the cofferdam that holds the
runoff to a certain level – in water that is ‘less than clear!’ Several
attempts were made in vain, but water pressure volume didn’t allow
divers to take off cofferdams without supporting or reinstalling them.
Thus, the EOC’s major task was to substitute the volume of explosive
and toxic gas with nitrogen, to inert the gas headspace. For this, Air
Liquide, a major supplier of liquid nitrogen and medical gases, was
contacted. At 7:00 am on Saturday the company urgently dispatched a
tanker carrying 26 m3 of nitrogen. The third option, which was to use
high-expansion foam, was put in place in the event of the nitrogen not
working. Due to the large volume to fill, a logistics operation was
coordinated during early Friday evening to raise the hydraulic system,
so it would be ready in the early hours of the morning on Saturday,
September 26. Throughout the night from Friday to Saturday,
firefighters and engineers from the Central Lab tracked the values of
explosimetry, by combining different technology devices (catalytic and
catharometric explosimeters), they also continuously updated the EOC.
However, no positive trend appeared before the implementation of
nitrogen inerting from 09:00.

A lengthy, but ultimately successful manoeuvre!
On the night of Saturday 26 and Sunday 27, the major effect of the
manoeuvres begins to work. Since 17:00, the teams providing the
records of measurements experiencing a frank and regular reduction
of the percentage of LEL. Around 23:00, the results oscillated between
8% and 11%, indicating that nitrogen inerting was efficient. It must
be said that in less than 24 hours, Air Liquide had emptied almost
three tankers of liquid nitrogen. It was then possible to pierce
the ceiling of this huge room with tools that were unlikely to cause an
explosion. Some ventilation openings were also briefly created with
explosion-proof forced air extraction fans. The methane was thus
removed and the final explosimetry threshold reduced to values
around 5% LEL. Once the EOC saw that the situation had
stabilized, he released most of the actors, public stakeholders and
assistance staff who had been ‘on deck’ for over 24 hours, putting in
place a streamlined and reduced monitoring for the rest of the night.
This intervention, which was relatively atypical in all chemical
interventions of the Paris region, has shown the benefits of a tight
collaboration between two Parisian utilities. It further showed the
benefit of having experienced hazmat specialist officers who are
trained in tactical reasoning, and able to apply their knowledge to
such situations.

This intervention occurred at a facility that is absolutely vital to
over six million Parisians, and the importance was obvious, as not
only did the Major General command the Brigade attend during the
first night, and then his deputy on the second day, but the Prefect of
the department and the Mayor of the city were also involved. An
aggravation of the situation would have amplified the damage, as it
already caused a shutdown of this strategic regional facility. Finally,
in the days that followed the end of the intervention, the engineers
provided a plausible explanation of the phenomenon, formulated in
the fault tree on page 36: HRW