

The Beirut explosion; an inconvenient truth for the industry and authorities

The devastating explosion in the Beirut harbour area was a dramatic wake-up call for the industry and (port) authorities worldwide. The cataclysmic event strongly proves the need for proactive risk management regarding large-scale storage of ammonium nitrate and other extremely hazardous materials.



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In recent decades this disaster-type had several precedents, the lessons of which industrial and governmental risk managers could and should have taken in account. The key to safe storage of agents that are sensitive to mass explosion is a combination of chemical knowledge, geography, safety policy, law enforcement and risk-based emergency management. When these conditions for risk mitigation fail an explosion like in Beirut could occur in industrial and logistic mainports anywhere in the world.

The Beirut event started as a small fire in a warehouse in the harbour area. The warehouse contained a mixture of stored products, including fireworks. After the ignition of the fireworks the fire escalated and spread to the adjacent storage of 2750 tons of ammonium nitrate. The potentially unstable base-product for fertilizers and explosives was stored in the area for six years already, after the Lebanese authorities impounded it together with the vessel that transported it. The customs office, aware of the potential risk, repeatedly asked the government to remove the dangerous cargo to a safer area, but the authorities failed to do so. The detonation of the 2750 ton ammonium nitrate storage wreaked havoc in the harbour and the adjacent urban areas. Nearly 200 people died and some 6500 were wounded.

'A recipe for disaster'

The devastating detonation and its preceding chain of events were the perfect recipe for disaster. The rapid evolution of the Beirut harbour into an economic hotspot over the past decades caused the harbour with its industry and storage

facilities and urban areas to converge. In fact the densely populated city-centre directly adjoins the harbour. As a result of these geographical characteristics Beirut harbour is principally unsuitable to store large amounts of toxic, inflammable and explosive materials.

The impact of the detonation proved that the Lebanese authorities lacked knowledge of the potential effects of a 2750 tons ammonium nitrate mass detonation. Also they didn't take in account the possible cascade effects of mixed hazardous materials storage. In addition, the Lebanese government lacked the capability to organise a strong risk-based supervision and safety law enforcement. At least the authorities did not respond to the possibly known risk as they should have. Also emergency management services (fire service) was not set up to suppress starting industrial fires quickly and prevent escalation. Nevertheless the Lebanese emergency services did a 'hell of a job' rescuing people under very difficult and dangerous conditions.

Scenario knowledge and learning from disasters

Proper knowledge of hazardous materials and their effects as well as lessons learned of previous disasters, prove to be crucial for industrial risk mitigation. Based on knowledge and experience the potential effects of a mass detonation can be translated into specific risk management measures. Such as the determination of safety zones and risk contours in spatial planning, in order to prevent convergence of industrial and residential areas. When existing situations of such urban-industrial convergence can't be changed, there is no other option than replacing extremely



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hazardous storage to less populated rural zones. In any case casualty prevention in residential areas should be the key-objective of proper industrial risk management.

Also authorities should have a good insight in the risk of mixed storage of products that can cause cascade effects in case of fire and explosion. A similar cascade effect like in Beirut occurred during the devastating explosion in the Chinese harbour city of Tianjin in August, 2015. 200 Tons of cellulose nitrate in a container terminal exploded. The explosion triggered the secondary detonation of 800 tons of ammonium nitrate stored adjacently, levelling vast areas of the industrial harbour area and damaging surrounding residential areas. The explosion resulted in 173 fatalities and 500 injured. Over 6000 people were left homeless. The terrible event in Tianjin should have been a wake-up call for the Lebanese authorities, knowing that a much larger amount of ammonium nitrate was stored in Beirut harbour. Those responsible for public safety in the Lebanese port should have asked themselves: "what could be the effect of an explosion of such magnitude in our specific situation"?

The catastrophic effects of the Beirut explosion can't be attributed exclusively

on the lack of a decisive government, proper rules and enforcement. Even western countries with well-established policy- and enforcement systems had disasters as a result of failing knowledge of scenarios and lack of enforcement. Let's focus on some examples of Dutch disaster history in recent decades.

Fireworks accidents

Both in 1991 and 2000 The Netherlands were shocked by major explosions in storage facilities for professional fireworks. The worst incident took place in the city of Enschede in the east of the country, on May 13, 2000. A rapidly escalating fire in the storage of SE Fireworks caused 177 tons of professional event fireworks to detonate simultaneously. 22 people died (including four firemen) and 947 got injured. The resulting urban fire ruined 500 residential buildings and fifty businesses. The residential quarter of Enschede known as 'Roombeek', looked no less than a warzone. Total damage was estimated at a billion euro.

The main reason for the devastating effect of the SE Fireworks explosion was that the company was housed in the middle of a residential area. A location completely unacceptable taking in account the possible effect-contours of

▲ Disaster-area 1991 at Culemborg: unexpected explosion of fireworks, lessons could and should have been learned: 2 casualties

a heavy fireworks mass explosion. Also the impact was strengthened by the fact that much more and also heavier fireworks were stored than regulations and permits allowed.

The Dutch authorities could have taken advantage of the lessons learned of a previous fireworks explosion that occurred on February 14, 1991 in the town of Culemborg. Two employees of MS Fireworks died in the explosion that levelled the company and caused extensive damage to several dozens of homes and farm-buildings. Dozens of people were injured. The impact in damage and casualties was limited in this case, due to the fact that the amount of fireworks in storage was much lower than in Enschede and, more important, the company was housed in a far less dense populated rural area. Nevertheless investigations by the Dutch scientific research agency TNO proved the sensibility for heavy professional fireworks for mass detonation. In their report TNO published several conclusions and recommendations to

improve the safety for fireworks storage and production (safety zones, testing and better risk-categorisation). However, lack of communication between governmental organisations involved in fireworks regulations, resulted in the report to remain 'on the desk' untouched. It was only after the dramatic Enschede-explosion that new strong fireworks regulations were put in force, but the damage had already been done...

Chemical fire

Another type of major incident that made headlines in The Netherlands was the chemical fire at the ChemiePack company in Moerdijk harbour, January 5, 2011. No explosive materials were involved and there were no casualties, but nevertheless the incident shows parallels with the disasters in Enschede, Culemborg and Beirut. In Moerdijk a fire broke out in an open storage yard containing

▼ **Disaster-area 2000 at Enschede: harder lessons needed to be learned: 23 casualties including 4 fire fighters**

intermediate bulk containers (IBC's), filled with extremely flammable liquids. The fire started small in a pump-facility with the actions of an operator without working-permit and activities outside any SOP. And when a pool-fire established the radiant heat and flames caused the fire to spread to the IBC fluid storage. The resulting inferno devastated the entire company and adjacent companies, had a big impact on industrial activity in the harbour and caused very extensive environmental pollution. Damages of 75 million, as of today the cleaning operation is still not entirely finished! Management of the company was held liable in person, and convicted.

Analysis of the Moerdijk fire showed that the company stored far larger quantities of flammable liquid than allowed and also on a non-suitable open air location without preventive facilities. Obviously the company acted against almost every hazmat regulation and showed a complete lack of awareness considering the risks of IBC storage in combination with open fire activities in the close vicinity. After the fire authorities strengthened their risk management,

oversight and enforcement of industrial safety- and hazmat regulations. Also a specialised industrial fire service by public-private partnership was established, since evaluation of the incident learned that the municipal fire service in the area was not fit for fighting industrial fires of this magnitude.

The basics of risk management

This article does not focus on the ineffective or absent Lebanese government that should have taken preventive actions, nor on the limited regulations for this type of hazmat storage or on corruption and criminal acts. It will undoubtedly have played an important role in the process towards disaster. Various sources proclaim that the amount of ammonium nitrate stored in the harbour was known and no actions were taken to remove the material or to mitigate the risks. Beirut was not the only place where this happened. What general lessons can be learned from the disasters described in this article?

First: quick economic development in industrial and harbour areas can result in unacceptable safety risks



Image courtesy of Rob Jastrzebski



Image courtesy of Port of Moerdijk

when companies and authorities lack knowledge of chemical characteristics and scenarios concerning large scale hazmat storage. Potentially unstable products like ammonium nitrate should in no case be stored in the vicinity of residential areas. Extended safety zones should be established around these storages. Also, governmental risk managers and industrial safety-specialists should invest in knowledge of cascade effects when various types of hazmat products are stored in a compact space. Knowledge that should be used in spatial planning for industrial- and harbour areas.

Second: governmental agencies in economic dynamic hotspots must stand strong in maintaining oversight on major safety risks and must be alert constantly on what's going on in storage facilities under their jurisdiction. They must be capable of authoritative intervention in case of high-risk storage activities. Such as ordering to replace dangerous goods or making specific requirements to lower the risks. For example ammonium nitrate can be mixed with additives that limit the risk for mass detonation. Also, setting limits for types and amounts of

certain chemicals can contribute to safety and prevent incidents that cannot be contained. In conclusion: a strong and reliable government is needed to enforce all necessary measures for safety.

Third: try to be absolutely clear on responsibilities of the owner of the goods and/or the storage facility. Define the need of safety management systems and anchor it in legislation or harbour's rules and regulations. And don't forget: demand sufficient insurance policies for goods stored and max damages of the risk that comes with the storage. Where authorities may be reluctant to be clear about coverage, insurance companies regularly are. And no coverage, no storage!

Last but not least: harbours and industrial areas with a high risk profile must rely on a risk-based emergency management organisation and fire service. Some disaster-types have very fast "escalation-signatures" and interference in the scenario is not feasible, but guaranteed and trained specialists regularly keep the incident small. Go for an organisation technically and operationally designed to cope with all

▲ **Moerdijk-harbor area 2011: high-risk industry with unprepared public services and unbalanced legal framework. Toxic waste and fluor containing foam**

credible types of incidents in a main port with chemical industry and storage. A properly designed, trained and equipped industrial fire service could effectively fight and suppress a starting fire before escalation. Such a dedicated emergency service also has the knowledge to determine whether fighting a storage fire is still an option or large-scale evacuation is the best thing to do. Knowledge of industrial activity, amounts of hazardous materials and their effects in case of an accident is the key to safety.

The explosion in Beirut was the 'perfect storm'. Everything that could go wrong went wrong. But nobody should make the mistake to think: 'This can only happen in Beirut'. History reveals a different, inconvenient, truth.

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