

Explosions of dangerous materials in a warehouse

12 August 2015

Tianjin, China

Explosions
Warehouses
Clean-up
Environmental impact
Intervention (difficult)
Dead
Injured

THE FACILITIES INVOLVED

The site:

Since 2011, the company had been operating a chemical warehouse on 46,000 m² plot of land in the Binhai economic zone, adjacent to the port of Tianjin. The port of Tianjin is considered to be one of the largest ports in northern China. The city of Tianjin alone has a population of 14 million.

The operator's activities involve the storage, transfer and distribution of hazardous chemicals. The company has seventy employees and generates an annual turnover of 30 million Yuan, i.e. 4.2 million Euros. The warehouse is located 500 m from the first dwellings.

Some the main products stored in the warehouse, include:

- Compressed and liquefied gases, including argon and natural gas;
- Flammable liquids, including ethyl acetate;
- Flammable solids, materials spontaneously combustible in contact with moisture, including sulphur, nitrocellulose and calcium carbide;
- Organic oxidisers and peroxides, including potassium or sodium nitrate;
- Toxic chemicals, including sodium cyanide, toluene diisocyanate;
- Corrosive products, including formic acid, phosphoric acid, methacrylic acid or caustic soda.

The amount of hazardous materials transiting the site is estimated at one million tonnes per year. According to information available, the mass of sodium cyanide on site was estimated at 700 tonnes at the time of the accident.



External storage facilities (photographs taken before the accident)



Source: Operator's website

Interior and exterior of a storage building (photographs taken before the accident)



Source: Operator's website

THE ACCIDENT, ITS CHRONOLOGY, EFFECTS AND CONSEQUENCES

Chronology:

A fire broke out at 10:50 pm; two explosions occurred around 11:30 pm while firefighters battled the accident with water. The first blast was the equivalent to 3 t of TNT, and the second was the equivalent of 21 t. A massive plume of smoke formed, followed by a large-scale fire. The response by the emergency/rescue personnel included several thousand firefighters, military personnel and police officers.

Photographs of the plume of smoke, during and after the explosions



Source: rights reserved

On 21/08, i.e. nine days later, four new fires occurred in the vicinity of the locations where the explosions had occurred.

Consequences of this accident:

The accident had significant repercussions and evolved over the course of days following the explosions, particularly in terms of the human, material and environmental aspects. The human consequences were exceptionally high. As of 15/09/2015, there were 173 deaths, 720 injured and 70 missing (mainly firefighters).

In terms of property damage, 17,000 homes were damaged, and 6,000 people were displaced. Buildings within a three-kilometre radius had their windows broken. A subway station, located 650 m from the explosion site, was also devastated. The methane terminal in the port of Tianjin (3 billion m³ of LNG/year) was affected by the accident, thus disrupting China's supply of gas for several months. An initial estimate evaluated the damage at between 1 and 1.3 billion euros. This amount was validated by the Chinese authorities' post-disaster investigation.

Aerial view of the site after the explosion



Source: rights reserved

Translation :

Cratère résultant d'une explosion	Crater from an explosion
Stockage de voitures neuves	New car storage area
Habitations	Housing
Rivière	River
Voie express	Express lane

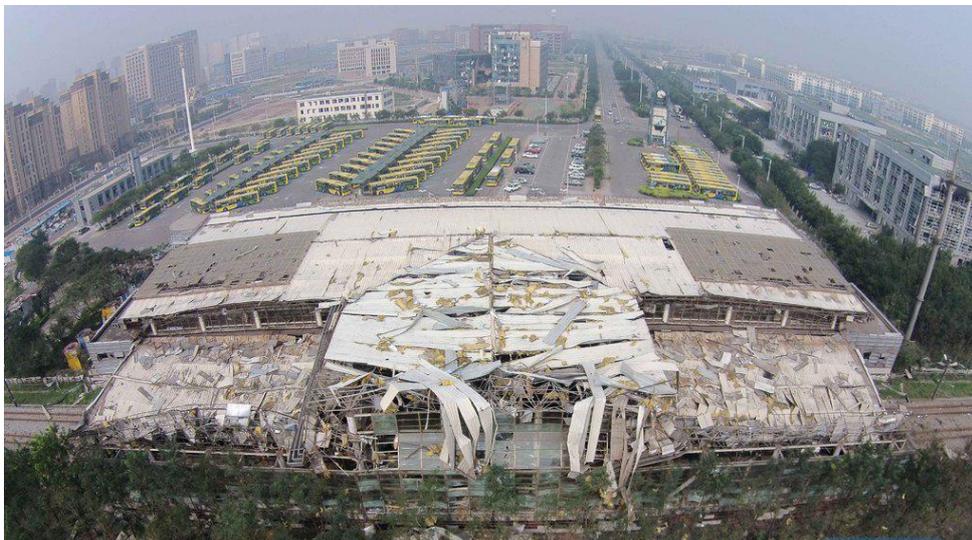
European industrial accident scale:

By applying the rating rules applicable to the 18 parameters of the scale officially adopted in February 1994 by the Member States' Competent Authority Committee for implementing the "SEVESO" Directive for hazardous substances, and in light of available information, this accident can be characterised by the following four indices:

Dangerous materials released							
Human and social consequences							
Environmental consequences							
Economic consequences							

The parameters associated with these indices and their corresponding rating protocol are available at the following website: <http://www.aria.developpement-durable.gouv.fr>.

Images of damage to public infrastructure:



Metro station after the accident (Source: rights reserved)



Projection of debris in a public park (Source: rights reserved)

Effect zones:



Translation :

Wednesday 12 August 2015

11:34 p. m. (local time).
Several explosions devastated the Binhai port area. Buildings damaged 10 km around.

All buildings 1 km around the explosion site were completely destroyed.

Source: rights reserved

Detailed damage analysis within a one-kilometre radius of the explosion site:



THE ORIGIN, CAUSES AND CIRCUMSTANCES SURROUNDING THIS ACCIDENT

Failure to comply with city planning (zoning) regulations:

The company was known to the Chinese authorities for its safety violations. It is alleged that a shareholder used his relationships to obtain the administrative permits required to operate the site.

The warehouse was located 500 m from the first dwellings. However, Chinese regulations stipulate that warehouses containing dangerous products must be located at least 1 km from residential areas.

Massive storage of explosive and combustible materials:

Investigations conducted by the Chinese authorities indicate that more than 11,300 tonnes of dangerous goods were illegally stored at the site. This number includes more than 1,000 tonnes of "explosive and combustible" substances, including 800 tonnes of ammonium nitrate, 680 tonnes of sodium cyanide and 290 tonnes of nitrocellulose.

Origin of the explosions:

According to the investigation report compiled by the Chinese administration, the explosions resulted from the spontaneous combustion of nitrocellulose in a container (see similar accidents in the ARIA database under Nos. 8039, 36073...). The container did not contain any stabilising agent that would have prevented the explosion. The fire created by the first explosion spread to other chemical substances, particularly the ammonium nitrates, which resulted in a second explosion.

Emergency response:

The lack of emergency preparedness was mentioned. Firefighters used fire hoses, unaware of the fact that some of the products stored react violently when in contact with water. This type of fire is extinguished with dry sand or powder.

In China, the fire brigade is made up of 130,000 people employed by:

- The Ministry of Public Health;
- Local governments;
- Private companies.

In the case of Tianjin, the firefighters belonged to the 3th category, in the sense that they were port employees. They were also very young (18 or 19 years old) and had little experience. According to the press, their training is extremely limited: physical training in the morning, short courses in the handling the equipment and a self-study manual. Their monthly salary is approximately 3,500 Yuan (500 Euros).

ACTIONS TAKEN

Crisis management:

Unlike an insecticide or herbicide, cyanide attacks the cells of all organisms (algae, mammal, fungus, fish, etc.). The entire food chain is thus threatened with a significant ecosystem imbalance.

In order to better manage the spread of pollutants, a containment perimeter was established over 3 km around the affected area. Sand and earth dams were built to surround an area of 100,000 m² around the blast site. The aim is to prevent any liquid leakage.

According to the Chinese authorities, sodium cyanide was found 1 km from the disaster. Pieces of the damaged containers were also examined for toxic materials. A specialised French company was commissioned to treat the area's wastewater using an oxidation process: the cyanide is transformed into cyanate, and then neutralised.

On 19 August, the Environmental Protection Office of Tianjin stated that the cyanide level in the river next to the site and in the sea along the edge of the evacuated area was well above the tolerance limits.

In France, maritime transport labour unions are concerned about the health consequences of the accident, particularly on goods stored in ships located in the port of Tianjin.

The Chinese authorities left several chickens and rabbits at the disaster site to reassure the population about the toxic products that were vaporised by the explosion.

Site rehabilitation:

Clean-up operations in the explosion zone were declared completed by mid-September 2015. The authorities have discussed a project to rehabilitate the site into an ecopark (construction planned for mid-2016). Also, the authorities in



Use of control animals
Source: rights reserved

Tianjin announced that they would buy back the devastated homes from their owners. The buyback price would be 1.3 times their estimated value as of 11 August (the day before the explosions) or their purchase price if higher.



Site rehabilitation work (Source: rights reserved)

Judicial follow-up:

The company's directors were arrested following the accident. The Chinese authorities are investigating whether abuse of power or negligence was involved.

In November 2016, the Chinese courts sentenced 25 officials to prison out of the 49 people tried in this case. The company's manager was given a suspended death sentence, commuted to life in prison, for his responsibility in the disaster.

LESSONS LEARNT

In France, the control of technological risks revolves around four principal objectives:

- Reduction of the risk at the source by reducing the amount of hazardous or polluting products at sites;
- Control of urbanisation around sites at risk (technological risk prevention plans around Seveso sites);
- Regular testing of emergency plans with the fire and rescue services;
- Information provided to the public about the risks involved.

In the case of the Tianjin accident, almost all of these principles were not respected: urbanisation control not respected around the site, storage of hazardous materials beyond the authorised limits with doubts on the administration's controls, young and inexperienced firefighters in relation to the risks incurred, etc.

Could this accident have occurred in France or Europe?

In Europe, and particularly in France, the site involved would be classified as an upper-tier Seveso installation. At the time of the accident, for sodium cyanide (without prejudice to the application of the rules governing the accumulation of other substances), the Seveso low threshold is 5 t and the Seveso high threshold is 20 t for this substance.

With 700 t of sodium cyanide present at the site, these thresholds are exceeded a great deal. In France and in Europe, this implies hazard studies, emergency plans (internal emergency plan, special intervention plan), information for the population, and a technological risk prevention plan, etc.

Even though it was a stationary warehouse that exploded (thus subject to the French classified facilities regulations and the Seveso directive), some people have wondered about what is being done in France with regard to the transport of dangerous goods (TDG) in ports.

The latter, where many containers are unloaded, are in fact not classified facilities or Seveso sites. However, they are subject to rules regarding the transport of dangerous goods (TDG) and the international maritime organisation which set out requirements for handling dangerous goods, particularly their isolation during unloading operations. Moreover, in

France, major ports are required to conduct hazard studies which may lead to additional measures being taken (e.g. distancing hazardous material storage facilities from populations).