Explosion of hydrocarbons in an urban sewerage network

April 22nd 1992

Guadalajara

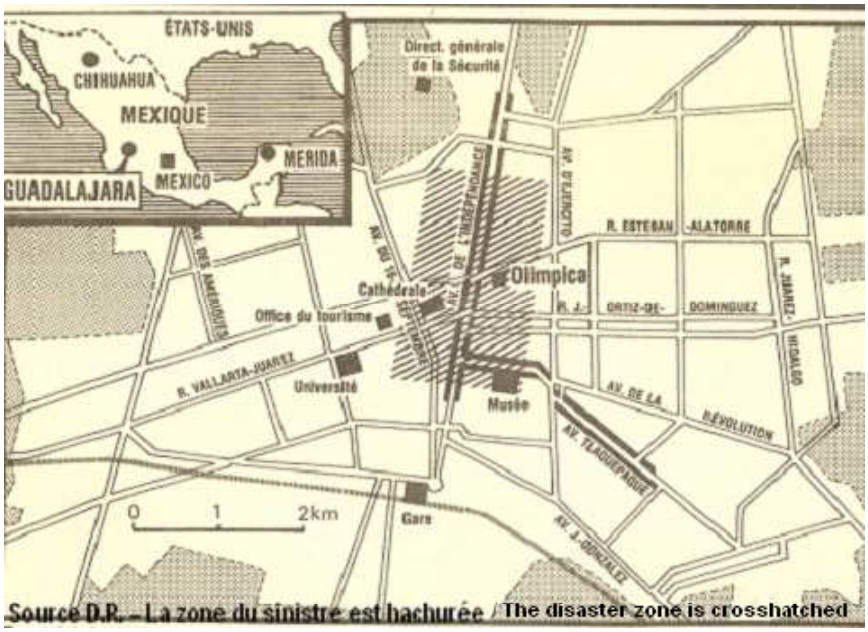
Mexico

Explosions
Pipes
Gasoline
Sewage network
Corrosion
Victims

THE ACCIDENT, THE SEQUENCE OF EVENTS, ITS EFFECTS AND ITS CONSEQUENCES

The accident

On Wednesday April 22nd at 10h09 an explosion occurred in the town drains of the city of Guadalajara (second largest city on Mexico) in the middle of an urban zone. This was followed by a series of explosions between 10h30 (16h30 GMT) and 11h30. Two further explosions occurred very early on Thursday morning, of which one in the industrial quarter of Alamos in the North of the town. The explosions resulted from the ignition of accumulated gas in the 3.50 m diameter main drain buried 8m below the roadway.



Source D.R. – La zone du sinistre est hachurée / The disaster zone is crosshatched

The consequences

- **Human consequences**

The official toll was: 206 dead, 500 to 600 missing, 1 800 injured and, in all, 4 500 disaster victims. Associations estimate that the catastrophe actually caused at least 1000 deaths, Wednesday was market day and the roads were full of people.

- **Material Consequences**

The successive explosions ripped up the roadways and shook of destroyed houses. Vehicles were thrown into the air and found buried beneath the rubble. The toll in terms of destroyed civil infrastructure amounted to 13 km of streets, 1500 houses destroyed, 1224 buildings and 637 vehicles damaged. According to the governor, the catastrophe caused damage worth 200 billion pesos (76 million Euros 2006).

European scale of industrial accidents

Using the scoring rules for the 18 parameters of the scale approved in February 1994 by the Committee of Competent Authorities of the Member States, in application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices:

The parameters comprising these indices and the method of scoring can be found at the following address: http://www.aria.ecologie.gouv.fr.

The index for "Dangerous substances released" (parameter Q1) is scored at level 2 by default, in considering the quantity of gasoline recovered (143m³), notwithstanding that the quantity of gasoline released was substantially greater.

The 206 deaths among the population explain the level 6 of the index concerning "human and social consequences" (parameter H3).

Finally, the damage estimated at 396 million francs (61,8 M€ ECU 1993) implies a level 6 of the index "economic consequences" (parameter €17).

The index for "environmental consequences" has not been scored, given the lack of information available on this subject.

THE ORIGIN, THE CAUSES AND THE CIRCUMSTANCES OF THE ACCIDENT

Following the explosions, suspicions were directed towards a petroleum company, which in turn implicated an oil manufacturing plant located close by the disaster zone. This latter plant appeared to have released into the sewers a large quantity of hexane used for the extraction of vegetable oils.

On Sunday April 26th 1992, the Attorney General of the Republic, charged with establishing the causes and the responsibilities for the catastrophe, considered, on the basis of judicial appraisal that the explosions were due to a leak of "ordinary" gasoline with the addition of hexane. In addition, the role of the hexane as detonator of the explosion had been refuted in view of its physical and chemical properties. The petroleum company later admitted that there were small quantities of hexane in the gasoline and the vegetable oil plant was exonerated.

8 days prior to the disaster, a loss of pressure in a 12 inch pipeline which carried the gasoline from the Salamanca refinery to the Guadalajara depot of the petroleum company was detected.

The loss of pressure was the result of the perforation of the pipeline, leading to a leak of gasoline. The leak was localised in the Alamo industrial area, less than 1 km from the storage tanks of the petroleum company. Town water pipes, probably made of copper coated with zinc – installed five years previously, had been installed close to the steel hydrocarbon pipeline without respecting standards for protection, provoking the corrosion and then the perforation of the pipeline. The gasoline thus poured out into the ground, infiltrating to a great depth (3 to 4 metres) before running into the drainage network as far as the next main drain, following the natural slope of the terrain.

The configuration of the town drainage network was also called into question. To solve a problem of an intersection between a main drain and a subway line, a siphon had been positioned on a sewage pipe, which created favourable conditions for the creation of an explosive atmosphere caused by the presence of gasoline remaining on the surface of the siphon (inhabitants had complained of the presence of vapour and of smells of gasoline escaping from the manhole covers since the 18th of April).

A series of measurements of explosiveness appears to have been conducted at the manholes and these appear to have revealed the potential risk of an explosion.

An explosive atmosphere in a confined space was created (presence of air and gasoline vapour) and the explosion could have been initiated by a metal/metal impact or more simply by a cigarette end thrown into a drain. .

THE MEASURES TAKEN

Expert appraisals conducted after the disaster

Trenches and 6 pumping wells were dug to limit the risk of contamination of the aquifer and the mixture of the sewage water and the gasoline. A volume estimated at 143 m³ of gasoline was extracted from the soil.

Foreign technical experts were charged with the control of the storage and distribution methods of the petroleum company. The objective was to evaluate also the existing potential risks, to set new safety conditions and to plan on response procedures in cases of emergency.

The petroleum company committed itself to the publication of a report on the state of all its installations (58 000 km of pipelines, 3 200 service stations) and to deal with the problem of illegal constructions on its installations.

Administrative follow-up

On April 30th, 1992, The Mexican Ministry of the Environment announced an action plan comprising 9 points :

1. Quantify the risks in the 50 largest urban and industrial centres;
2. Conduct ecological audits for potentially dangerous companies;
3. Analyse the risks involved in the networks of the petroleum company in several states of the country ;
4. Conduct periodic tests on the composition of the liquids and the presence of gas in the sewage network ;
5. Dialogue with private companies to establish programmes for the prevention of accidents and the installation of safety equipment;
6. Reinforce the civil defence system: create committees in the 50 largest urban centres, in order to provide support to populations in the case of disasters and to gather information from industrialists ;
7. Enlarge the list of activities considered to be dangerous, in order to improve the control of such activities;
8. Regulate the transport of dangerous substances;
9. Arrange meetings of experts to establish ecological standards, apply them and provide surveillance for them

Reparations

The petroleum company participated in the reconstruction of the disaster zone, in particular by the construction of a provisional open air main drain 1 500 m long.

The World Bank provided the necessary funds for the construction of a new main drain.

THE LESSONS LEARNED

The heavy human cost of this accident underlines the potential danger caused by the presence of a pipeline carrying dangerous fluids in a heavily populated zone. Special care needs to be given to the definition of the establishment, the archiving and the use of plans, as well as the construction, surveillance and maintenance of these constructions.

As regards experience gained which can be transposed to classified installations, it is worth noting that :

- The massive and uncontrolled spreading of inflammable volatile liquids in a confined space (sewage network) can generate major risks for people, assets and the environment;
- Accidental spills, linked to transport, loading/unloading or use of dangerous substances within industrial plants and their propagation in the drainage network deserve to be examined in risk studies and taken into account in emergency plans.
- On the organisational front, it is desirable to check regularly for the presence of gas as well as the composition of liquids found in sewers.

Comparables :

- Accident at the Petite Couronne (Aria n°2257) ;
- Accident at Chavanay (Aria n°2438) ;
- Accident at La-Voute-sur-Rhône (Aria n°4225).