

## Fire in an archive warehouse

January 28<sup>th</sup> 2002

Roye [Somme]

France

Flash-over  
 Warehouse  
 Paper  
 Smoke clearance  
 Automatic extinction  
 Water supply  
 Domino effect

### THE INSTALLATIONS CONCERNED

#### The site :

The warehouse concerned was operated by a service company which handled the computerised management, the conservation and the legal safeguard of “paper” archives for its clients. It was installed in the East of the Somme department on the AMIENS-LILLE axis where the presence of a motorway exchange point facilitated the installation of numerous other storage warehouses.

It entered service in 1992-1993 in the absence of any request for authorisation. The company was authorised to operate this site following a request for regularisation by decree from the prefect dated 14<sup>th</sup> January 2002 under the terms of paragraph 1510 of the legislation covering classified installations for the storage of combustible materials in quantities above 500 t in covered warehouses.



The warehouse before the fire on January 28<sup>th</sup> 2002.

#### The warehouse concerned by the accident:

It was intended for the storage of archives (paper, cinematographic and medical archives...), its capacity could reach 63 200 m<sup>3</sup>. According to the file submitted requesting regularisation, the warehouse comprises two connecting buildings respectively of 1 838 m<sup>2</sup> and 3 630 m<sup>2</sup> of ground surface area, metal framing of 8.5 m and 12 m height under structures of which the walls were of metal cladding. A two floor administrative area was attached to the north façade. The separation of the buildings consisted of a partition of masonry blocks with a separating door with no particular fire resistant qualities.

The authorisation file mentioned roofing in incombustible materials class (M0) with the exception of a part if the inner lining of materials in class M1.

Standardised cartons were stacked on metal racking to the full height of the building. These racks were laid out on both sides and perpendicular to a lengthwise central corridor of a width of 2,25 m. Access for the personnel to the various storage areas was via intermediate lateral passages of 0.80 m width, arranged at several levels (up to 5) and composed of metal gratings. The various levels were served by an elevator and by spiral staircases. An peripheral passageway (0.87 m wide) was provided on the ground floor all around the interior walls of the buildings to provide access to the emergency exits.

The storage areas were equipped with fire-hose points and an automatic extinction system involving two intermediate layers, protected against frost and connected to 2 reserve tanks of 630 m<sup>3</sup> and 30 m<sup>3</sup> via pumps capable of supplying 17.5 l/mn/m<sup>2</sup>. There was also a “fire brigade tank” of 120 m<sup>3</sup> capacity. Two fire risers were available at less than 200 m of the site.

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

### The accident :

**On Monday January 28<sup>th</sup> 2002, around 10 h**, when the fire service was called, localised sources of fire were found in the fifth bay of the warehouse and the fire had already attained the second level which was accessible by a spiral staircase. The fire was threatening the upper levels.

According to the fire brigade, the system of remote surveillance would have detected the fire at **10 h 03**, and, at the same moment the first sprinkler heads started to operate.

The fire brigade arrived on site at **10 h 13**.

They observed white smoke emerging from the channels in the roofing of the two upper cells at a height of 8.5 m and 14 m from the acroterion. Firemen entered the warehouse and localised a first source at the level of the 5<sup>th</sup> bay, several sources were found at the end of the warehouse on the ground floor. The emergency services still had good visibility. The smoke was limited to the upper regions between the 3<sup>rd</sup> and 4<sup>th</sup> landings.

The firemen set up hoses to limit the fire sources and several of these were rapidly mastered. It would seem that when the firemen entered the building, only a few sprinkler heads were operating and that the motor of the main pump had not started up...

The warehouse then filled up with smoke. The ventilation configuration of the warehouse seems to have favoured the driving down of the smoke coming from the entrance of the cell and causing the firemen in the building to be surrounded. The firemen were then confronted at around **10 h 20** by a sudden ignition of the smoke and of the entire warehouse. The smoke, which was very hot and loaded with inflammable gas from the pyrolysis of the stored paper and cardboard had spontaneously ignited (the flash over phenomenon).

Following the ignition of the blaze in this zone, the firemen evacuated the cell in the darkness, the cell lighting having failed.

Under the increasing pressure of the pyrolytic gas, two powerful explosions were heard inside the cell, causing the opening of the smoke evacuation systems. Screw jack shanks were found to have been projected over some 20 meters.

During the following thirty minutes, the smoke reduced visibility to a few meters. The emergency vehicles arriving as reinforcements could not approach the warehouse on account of the zero visibility, the crews of the first emergency team went on foot to meet the reinforcements.



Photo DRIRE PICARDIE

Warehouse on fire, the (wind blowing towards the source)

At 11 h, the external structure of the warehouse collapsed inwards. The internal racking and gangways had already collapsed and did not resist the fire for more than half an hour.

The flames reached a height of some fifteen metres. These were beaten to the ground by the collapse. Meteorological conditions were characterised by a violent wind of over 100 km/h which probably stoked up the fire but also violently dispersed the hot gases and considerably reduced the lateral heat radiation.

The wind changed direction, but at the height of the fire, it was fortunately oriented to the East towards the next plot which was intended for extensions to the warehouse and was thus unoccupied over a distance of about 200 m as far as a regional road which crossed the industrial zone.

Following the collapse of the cells, the wind spread burning papers over several hundreds of metres. The fire brigade set up security measures around a petrol station located at 200 m downwind..

Having been warned at 10h30, the inspectorate of classified installations arrived on the site of the accident at around 11h15.

The warehouse burned all day. Stoked by the wind, the fire was not totally extinguished until four days later.

**The consequences :**



Photos DRHE PICARDE



The fire destroyed the two cells of the warehouse and everything that they contained: the archives of several financial companies and a part of those of public hospitals. The structure of the larger cell was totally ruined. The cladding of the smaller cell survived on account of the protection provided to the administrative building by the firemen. The cost of the damage not being available, this information does not appear in the scale below.

**European scale of industrial accidents**

The accident at Roye did not involve any release of dangerous substances and had no human, social or environmental consequences. On the other hand there was a financial impact which, in the absence of an estimate of the damage, can not be characterised by the scale approved in February 1994 by the Committee of Competent Authorities of the Member States for the application of the 'SEVESO' directive

Dangerous materials released		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Human and social consequences		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Environmental consequences		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Economic consequences		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The parameters comprising these indices and the scoring methods used can be found at the following address: <http://www.aria.ecologie.gouv.fr>

## THE ORIGINE, CAUSES CIRCUMSTANCES OF THE ACCIDENT

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The circumstances under which the fire at the warehouse started are unknown but the phenomenon of flash over observed enables a scenario to be envisaged.

Indeed the flash over observed resulted from a long process which was probably initiated well before the setting off of the fire alarm by an incubating fire, without smoke.

A source of fire appeared in the centre of the warehouse. This was very limited at the outset, but grew and started to heat up the surrounding materials. On account of the configuration of the racking, chimney phenomena must have encouraged the vertical propagation of the fire while accentuating the thermal radiation and the release of super-heated smoke loaded with inflammable vapours

The start of work by the employees of the company on the Monday morning could have contributed to the creation of an air current feeding the source of the fire with oxygen and favouring the sudden acceleration of the fire and its spreading to the whole warehouse.

## THE MEASURES TAKEN

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The fire on January 28<sup>th</sup> 2002 having put out of service the storage warehouse of the operator, the inspectorate of classified installations proposed, in conformity with the decree of September 21<sup>st</sup> 1977 that the prefect subject a new start-up of operations to a new authorisation.

The prefect abrogated the prefect's decree of January 14<sup>th</sup> 2002. The operator subsequently decided not to conduct operations on this site and opened a file for the cessation of operations.

## THE LESSONS LEARNED

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The fire clearly showed up the consequences in terms of the development of the fire of certain elements of non-compliance with the former regulations applicable to storage warehouses (technical instructions dated February 4<sup>th</sup> 1987), as well as the specifics of the internal arrangements as applied to the warehousing and management of archives by the company.

### Fire-fighting measures:

The warehouse was supplied with extinguishers, with fire-hose points and with an automatic extinguishing system. It appears that when the employees became aware of the fire, they attempted to master it by using both water and powder extinguishers but that on the other hand, for undetermined reasons, the available fire-hose points with far greater extinguishing power were not used.

When the fire brigade intervened, the reserves of water and the flow rate of the public network were found to be insufficient. The fire reservoir had a capacity of 120 m<sup>3</sup> and the site could only make use of a single fire outlet with a flow rate of 52 m<sup>3</sup> / h at 1 bar. In its study of the dangers, the petitioner indicated that two fire outlets were present close to the site. In any event, these were located on the same pipe and the emergency services could only use one, given the low flow-rate level. The fire brigade was obliged to rotate their vehicles to supply the site with water.

### Smoke clearance :

Smoke clearance was provided for in the larger cell by automatic smoke vents without any fusing element under the effect of heat. For the smaller cell, no smoke evacuation system existed; the cell had no fusible element operating under the effect of heat. (these had been blocked during the renovation of the roofing).

When the emergency services arrived, white smoke was pouring out of both cells at the level of the gutters. The warehouse was smoke-filled for more than half of its height. The smoke was limited to the 3<sup>rd</sup> level. The flash over phenomenon observed demonstrates the very high temperature level of the smoke. The smoke clearance mechanisms did not work. These finally opened from the blast effect of the explosion of the gases in the warehouse

This type of phenomenon was not included in the scenarios described in the risk study. The same is true for the quasi total loss of visibility that would have been created by the smoke had the wind direction been to the North towards the closest neighbours.

The smoke contained in the upper regions of the warehouse should have set off the fire alarm and automatic extinction.

### Fire detection:

It appears that the alarm was only raised belatedly. The detection systems operated at the same time that the emergency services in Roye were alerted. This fact had serious consequences on the intervention of the emergency services. The fire brigade left for an intervention in a paper storage warehouse equipped with sprinklers. On their arrival, the automatic extinction devices were not operating as they should, which placed the firemen in a situation of danger.

### Emergency exits:

Access to the racking was via gratings throughout the 5 levels. Access to the various floors was by spiral staircases. 4 staircases led to each level. The emergency exits were on the ground floor which obliged the personnel to descend via the central staircases to reach the emergency exits. Maximum distances to be covered (or 40 m from an emergency exit or 25 m in the case of the parts which were blind alleys) were not respected. The operator had planned to place an emergency exit on the façade for the whole height of the building to facilitate evacuation. This plan had not been implemented. During the intervention, the firemen had difficulties in intervening at the level of the racking on account of the insufficient width of the access passages.

### Fire resistance of the structure:

The structure of the warehouse was metallic. The cells were separated from each other by a wall in full breeze blocks supported by the metal structure of the larger cell. The "firewall" ended at the height of the smaller cell.

The collapse of the structure of the large cell generated the fall of the firewall and destabilised the structure of the smaller cell. The fire resistance of the internal structures was very clearly inferior to half an hour. The metallic structure of the warehouse resisted the fire for about 45 minutes.

### Risk analysis:

The risk analysis produced by the operator did not sufficiently take into account the specifics of the layout and the operation of the depot:

- The narrowness of the passages and the organisation of the storage were shown to be extremely dangerous for the emergency services on account of the non-compliance with the minimum distances to be covered to reach an emergency exit.
- The consequences of the layout and the alternation of gratings on the evolution and propagation of the fire, in particular the chimney effect accentuating the propagation of the fire,

Furthermore, the study of dangers in modelling the consequences to the environment of a possible fire had omitted certain scenarios which could have produced domino effects. The fire, stoked by gusts of wind from 80 to 100 km/h caused flaming elements to be spread over more than 200 m obliging the fire brigade to set up a perimeter around a petrol station.

It should be noted that a part of these subjects (size of the zone affected, fire resistance of the structures, aggravation of the fire on account of internal layout and evacuation distances) had been the subject of several requests for detailed examination by the inspectorate of classified installations, both directly to the operator and to the firm intervening as third party experts. The inspectorate had then proposed that the issue of an authorisation by the prefect be subordinated to bringing the warehouse into prior compliance.