Toxic release in a frozen food warehouse

23 April, 2005

Nemours – [Seine-et-Marne] France

Toxic leak
Food industry
Refrigeration / Ammonia tank
Organisation
Training
Work
Emptying

THE INSTALLATIONS IN QUESTION

The company and the administrative context:

The company concerned by this report stores, packages and distributes food products. It operates several hundred frozen food stores.

Located in the Nemours industrial estate near the A6 motorway (Nemours rest stop), the establishment employs 236 people and consists of 2 buildings separated by a public thoroughfare:

- ✓ A "Distribution Platform" built in 1979 and expanded in 1984, which houses a packaging workshop and a cold room using a halogenated refrigerant.
- ✓ A "Storage Logistics Warehouse and Workshop", built in 1987, which houses a laboratory and a cold storage facility coupled to a refrigeration installation operating with ammonia (NH_3); these installations contain a maximum of 2 tons of NH_3.

The public is received in a 360-m^2 store reserved for frozen food products.

The Nemours establishment is governed by a prefectoral order dated October 15, 2003, authorising it to continue operating its installations. This order clearly stipulates the provisions of the Ministerial Order of July 16, 1997 relative to refrigeration installations using ammonia as a refrigerant.

The installations concerned:

The equipment responsible for the accident was a pressure tank, identified as No. 0935. Its rated capacity is 450 kg of NH_3. Its maximum service pressure is 32.5 bar and its operating temperature between -20 ℃ and +50 ℃.

The tank was equipped only with filling and drainage valves and was not equipped with any pressure accessory such as a "pressure gauge" or "safety valve" (see photo).

The tank was rented from a chemical product importer/distributor by the service provider in Nemours. This order did not require that a tank filling procedure be provided. The service provider was however required to attend certain internal training programs held on the distributor's premises.

According to the equipment log, the pressure tank had undergone hydraulic testing less than 5 years ago, in compliance with the provisions of article 13 c (bis) of the order of dated July 23, 1943.

THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident:

Safety improvement operations on the refrigeration installation were scheduled April 20 to 26, 2005 in order to replace the condenser and the valves on the cold production system in which the NH_3 circulates under pressure.

In order for these operations to take place in the proper conditions, part of the NH_3 had to be emptied from the installation. The operation took place on Friday, April 22nd. Of the 2 tons of fluid in the circuit, 500 kg remained isolated in the "evaporator" portion not concerned by the operations, 1,500 kg of NH_3 at - 18°C being transferred into four 450 kg tanks rented by the subcontractor specialised in maintaining and monitoring refrigeration installations.

Three full tanks and a fourth half empty were then stored outside the warehouse under guard.

One of the tanks burst Saturday, April 23, 2005 at 11.50 am, releasing 450 kg of NH_3. None of the tanks had been handled during their storage period.

The consequences:

A toxic cloud effected roughly one hundred people in the industrial estate, including 21 warehouse employees, and third parties parked in the rest area 200 m from the tanks.

The internal contingency plan was initiated at 12.15 pm.

Significant human and equipment resources were put into action: including roughly one hundred firemen, forty vehicles and 2 helicopters. The rescue services reported 52 victims, 28 of which were hospitalised that evening for analyses, 5 being more seriously effected: 2 *gendarmes*, 1 truck driver in the warehouse and 2 individuals suffering from asthma.

A security perimeter of 150 m was set up, a road was blocked off and lighted sign messages indicating "rest area closed, close car windows and stop fans" were set up on the motorway.

Firemen equipped with PBA diluted the NH_3 fumes with ""peacock tail" fire nozzles, one near the ruptured tank and a second directed toward the road to shield the nearby rest area. In order to maintain a sufficient retaining capacity during the operation, the dilution water collected in a 300-m³ basin were released into the network after its pH had been controlled (8 to 9); 550 m^3 of water was used and released after the pH check. The NH_3 tanks still intact were transferred to the refrigeration unit.

The rest area was reopened at 9.26 pm. The rescue services ended their intervention at around 10 pm. The store resumed its activities Sunday, April 23rd.

European scale of industrial accidents:

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States that oversees the application of the 'SEVESO' directive, and considering the available information, the accident can be characterised by the following 4 indices.

The parameters that comprise these indices and the corresponding rating method are available at the following address: http://www.aria.ecologie.gouv.fr .

The 450 kg of ammonia released into the atmosphere represent 0.23 % of the corresponding Seveso threshold (200 t), or level 2 of the "quantities of dangerous materials released" index according to parameter Q1 (0.1 to 1%).

Three parameters are used to determine the rating of the "human and social consequences" index: H3, H4 and H5.

Parameter H3 is 0, no deaths occurred as a result of the accident.

Parameter H4 is also level 0, no one was seriously injured.

Parameter H5 is level 4, 28 members of the public were effected and hospitalised as a precaution.

As a result, the overall "Human and social consequences" rating is 4.

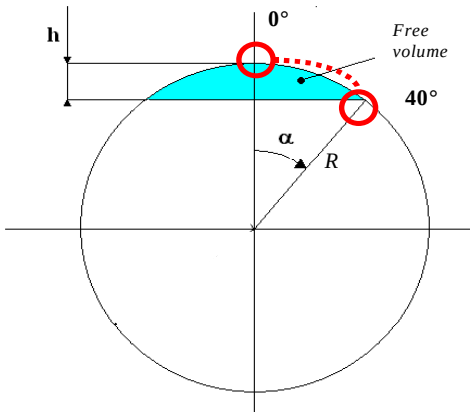
ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The rupture of the pressurised tank was the result of abnormally high pressure in the tank as a result of overfilling.

Considering the significant variation in temperature during the storage period of the NH_3 drained from the refrigeration installation, the dilation of the liquid contained in the tank increased the pressure and ruptured the tank.

These "multipurpose" tanks and their filling method may be the cause. These tanks were actually designed to store liquefied gas or liquids. The filling rate is thus able to vary between 85 and nearly 100%.

The coefficient of 85% is obtained by aligning one of the 2 painted marks with 40° angle on the side o f the tank. The operator can thus position the eduction pipe (built into the tank) allowing the NH_3 to discharge before the entire available volume is filled up. The tank's positioning is thus extremely important as shown in the following diagram:



It was noted that, due to the design, the end of this discharge tube is a variable distance from the cylinder wall: It cannot thus fulfil its role with precision.

Next, one must admit that the volumetric method used to transfer product cannot adequately guarantee filling of tanks more than 430 kg. This quantity is very close to the tank's maximum quantity, particularly during filling operations at very low temperatures (-18 °C).

Furthermore, the procedure provided did not correspond to the tank model used, and thus to the marks indicated on the body of the tank.

Finally, the probability of error was increased by the multitude of various types of position marks (corresponding to various operating modes: filling, transfer, storage or drainage) without documents being provided explaining their meaning, and thus their use.

Furthermore, accidental mixing of incompatible substances cannot be fully excluded between 2 successive uses. In this case, just the presence of water after possible rinsing and insufficient drying is incompatible with the "refrigeration quality" (minimum purity 99.95%) of the anhydrous NH_3 or R 717.

ACTIONS TAKEN

Administrative and penal actions:

Following this accident, the Prefect required the operator to conduct the following within a period of 2 months:

- complete its danger study with a precise evaluation of the possible consequences of a similar release with a proposal of measures to reduce the consequences of a similar leak
- reinforce its internal contingency plan
- review its procedures concerning its filling operations

Next, within the scope of regional action, the prefect initiated a complementary order outlining organisational and technical provisions intended to reduce the probability of an accident. In compliance with the conclusions of the *Pôle National d'Expertise des Appareils à Pression*, the quantity of NH_3 introduced into the tank must be weighed when the operation is not performed in a confined environment.

Finally, a legal procedure must determine the levels of responsibility of the players involved in the accident.

Technical actions:

After having planned out several provisions to reduce the area of impact in the event of a similar accident, the operator changed its facility (tubular heat exchanger replaced with a plate heat exchanger, etc.) thereby reducing 600 kg of NH_3 load in the facility which no longer comes under a authorization procedure (only declaration procedure). The replacement of existing equipment freed up sufficient space in the machine room to store transfer containers. The construction of a dedicated loading dock makes it easy to handle containers.

In case of a similar maintenance operation, the NH_3 barrels will be stored in the machine room. In the event of a leak, the toxic fumes will automatically be directed towards the chimney of the room reducing the exposure of staff while channelling and diluting the toxic cloud.

From the organisational point of view, the operator reinforced its internal contingency plan and reviewed its maintenance procedures by paying particular attention to greater formalisation of the NH_3 tank filling and draining procedures.

LESSONS LEARNT

This accident highlighted certain procedures for handling liquefied toxic gas which could present significant dangers, and not explicitly outlined by the Ministerial Order of July 16, 1997 or by good practices.

From the equipment point of view, one could question the use of simple "multi-purpose" tanks, not equipped with a safety valve or other pressure or fill limiting device and which is not maintained in a safety position by a metal frame (like most NH_3 containers).

From the organisational standpoint, it would appear that this type of handling requires much stricter procedures than those currently in place.

At any rate, this feedback has lead the Ile-de-France DRIRE to propose a additional requirements at the regional level regarding prefectoral orders, requiring that operators comply with a certain number of organisational and technical provisions aiming to reduce the probability of a similar accident, notably by weight a container to ensure the quantity of fluid introduced in the tank as soon as the operation is not performed in a confined environment.