Ammonia Loading Line Rupture

A brief case history describes a major rupture accident at the Swedish fertilizer plant receiving terminal docks at Landskrona.

R. Hakansson,
Supra Aktiebolag,
Landskrona, Sweden

A serious accidental rupture of a rubber hose unloading anhydrous ammonia from a tanker to a quay-side storage sphere, which caused two deaths, has led to an improvement in procedures at the Swedish fertilizer company, Supra A.B.

Supra's production capacity totals roughly 1,500,000 ton/yr. of fertilizer with its current production program. Capacity for intermediate products (nitric acid, phosphoric acid, and ammonia) is about 500,000 ton/yr. Company employees total about 1,350 at four different producing centers.

The Landskrona complex, in the far south of Sweden, produces half the total fertilizer output but no ammonia. All the ammonia consumed there—about 80,000 ton/yr.—is imported from different producers in Europe. Half of it is transported by rail and half by tankers to Landskrona.

The tankers carry a cargo of 500—1,300 tons each; and unloading capacity varies between 40 and 150 ton/hr., depending on the capacity of pumps and compressors.

Normally the tankers use their own equipment. The rubber hoses for connection to Supra A.B.'s pipe lines on the quay, seen in Figure 1, always belong to the tankers.

The anhydrous ammonia is stored under pressure in two spherical tanks, of 1,000 and 2,000 tons storage capacity respectively.

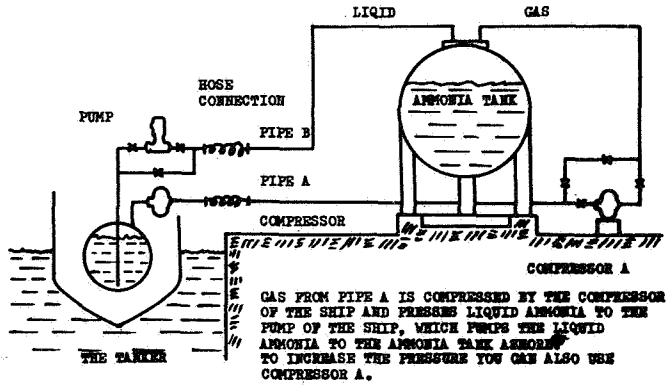


Figure 1. Schematic diagram illustrating Supra's arrangement for unloading anhydrous ammonia from tanker to dock storage sphere.

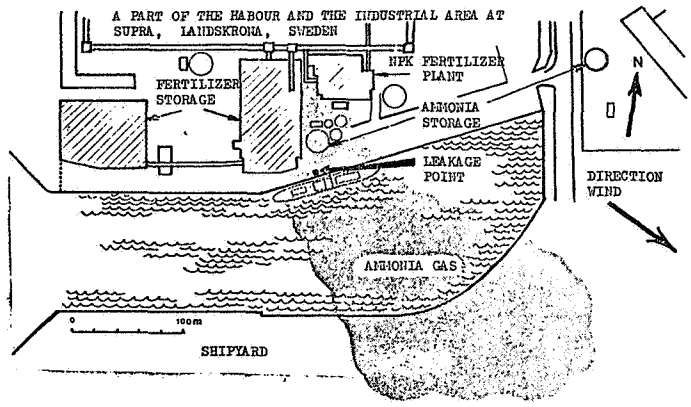


Figure 2. Plot plan of Supra's dock arrangement, showing how the ammonia gas spread during first few minutes after the rupture.

The Belgian tanker M/S "Rene 16" arrived at the port of Landskrona in the evening of January 16, 1976, with a cargo of 533 tons of anhydrous ammonia, under a pressure of about 5 atm. On this occasion, Supra's compressor had to be used for unloading the tanker, as the pumps and compressors on board the tanker were being repaired.

At 18.35, unloading was started at a rate of about 45 ton/hr. All conditions were normal until just after midnight, when the liquid hose ruptured with a loud bang.

The Supra employee on the quay immediately closed the hydraulic valve in the liquid line, and then ordered the compressor operator to stop the compressor and close the valves. At the same time, the Supra engineer on duty called the fire brigade, the police, and Supra's emergency force.

After about ten minutes, the firemen arrived. Two of them were provided with protective clothing and breathing equipment. The tanker was by that time completely enveloped in a cloud of ammonia gas, as shown in the plot in Figure 2, and liquid ammonia was still spurting onto the quay. The two firemen with the protective clothing went on board and closed the ball valve on the discharge line.

Time elapsed between the rupture to closure of the valve

on board was about 50 min. and the amount of ammonia which had leaked out onto the quay was about 180 tons. Figures 3, 4, and 5 are photographs of the hose connections before the incident and the appearance afterward.

The tanker had a crew of seven men. Five were found shortly after the accident and two were taken to hospital. The firemen searched through the entire ship but could not find anybody. When the ammonia cloud had dispersed after about one hour, the remaining two members of the crew were found dead east of the tanker on the quay.

Cause of deaths determined

An investigation of the accident started at once, and the cause of death of the two men, the captain and the first mate, was established. They had been drenched in liquid ammonia, which had resulted in edema of the lungs. They had been standing close to the rubber hose when it ruptured and had then run in the wind direction.

Nobody on the tanker was standing in such a position that they could close the quick-closing valve, which was remote controlled from two places on the ship. If the valve had been closed, only a small quantity of anhydrous ammonia would have leaked onto the quay.

The shipowners, Derca, of Antwerp, Belgium, had bought the rubber hoses from Dessoy, of Antwerp, the hoses were marked as follows: "ANTI STATION HP PROPAN BUTAN HOS. Working Pressure 290 psi. LIGAFLEX, DESSOY ANTWERPEN".

The salesman had recommended this hose instead of a hose for ammonia. Both products are described in Figure 6. The Swedish State Testing Laboratory has tested the ruptured hose and has come to the following results:

"The hose has a thickness of 11mm. and is built up of two layers of acrylonitrile-butadiene rubber. The reinforcement has three layers of polyester fibre [ethylene terephthalate/

Figure 3. Hose connection on board the tanker.

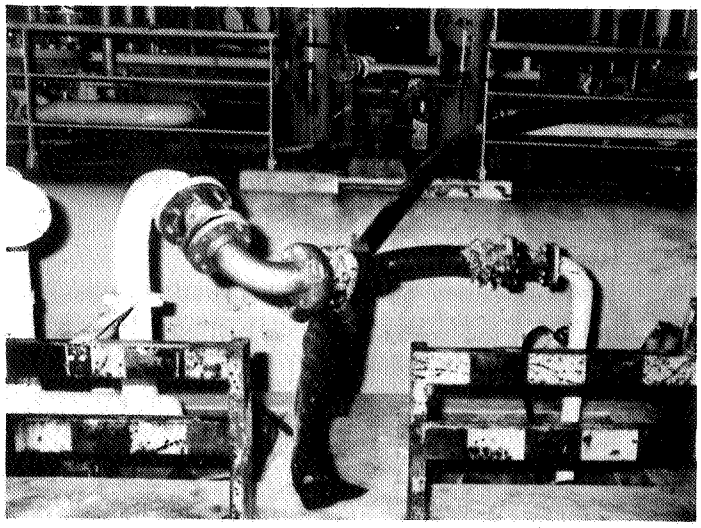


Figure 4. Hose connection on the quay.

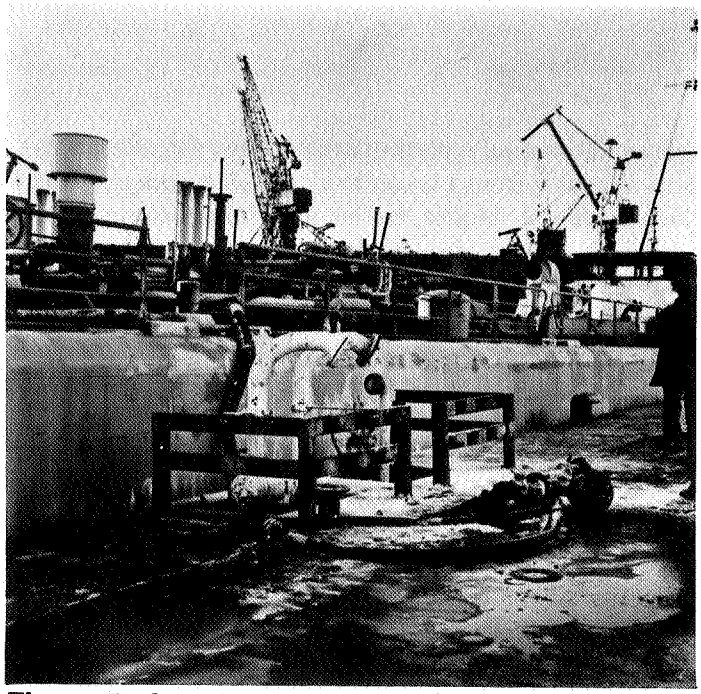


Figure 5. Condition of connections after the accident.

Figure 6. Specifications sheets covering the two types of liquid transfer hoses discussed in this article.

sebacate (70:30) copolyester] and one layer of cotton.

"To make the hose antistatic there is a one mm. copper wire inside the cover rubber.

"The polyester in the ruptured hose was totally destroyed by a form of hydrolysis resulting from the action of ammonia. The products of this ammonolysis are glycol and acid amides.

"The cotton layer was not attacked but the copper wire had in some parts of the hose totally disappeared. If cupric salts are dissolved in ammonia the compound formed can attack cellulose.

"The inner rubber layer had hardened and showed a number of cracks. The breaking stress had decreased from 134 to 56 kp/cm^2 and the elongation of rupture from 304 to 84% . The hardness of the rubber had changed from 80 shore A to 65. The Testing Laboratory summerize the testing results as follows: The rubber hose is of a very high quality if it is used for propane and butane. The rubber quality and the reinforcements are resistant to these substances. But this rubber hose is completely unsuitable for anhydrous ammonia."

Preventive measures taken

After the accident, a number of meetings were held with people from the harbor authorities, the Swedish Technical Control Institute, and the State Maritime Department of Sweden. The Landskrona City Council has appointed a committee for discussing the safety regulations for handling ammonia. The Harbour Board of Landskrona has decided that the following regulations should be put into practice. The regulations are to be considered as temporary and are valid until further more comprehensive regulations are issued.

"The master of a vessel discharging ammonia in the port of Landskrona is responsible for the operations aboard the ship. The following points are to be observed:

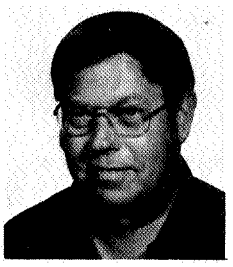
1. The discharging operations should always be supervised by an officer who well knows the ship and its equipment. He should be assisted by a special watchman instructed about safety regulations.

2. Before the discharging starts it should be controlled so that the right kind of hose is used and that the hose is properly connected. The master should on request from a harbour officer present a certificate of the hose showing that the hose is made of material resistant to ammonia. The hose should have been tested within the last 12 months.

3. On request from a harbour officer or receiver the master should point out where the ship's remote quick-closing shut-off valves and emergency shut-downs for pumps and compressors are situated. Such devices should be easily available and always kept clear.

4. Personnel aboard the ship engaged in the discharging operations should always keep breathing equipment or respiratory protection suitable for ammonia ready for use."

Supra A.B. is now building a 30,000-ton capacity ammonia storage terminal for atmospheric pressure. Contractor CBI is Chicago Bridge & Iron. The unloading will then be done with loading arms instead of rubber hoses. #



HAKANSSON, R.