Ammoniakutsläpp på en fabrik för produktion av urea.

890706 MARS 1989_21

Två operatörer skickades ut för att undersöka en pump som förde påtagligt mer oväsen än den borde göra. Klockan 15:30 slog vevhuset sönder av vevaxeln i en pump som användes för att höja trycket på ammoniak från 2 till 24 bar. De två operatörer som befann sig i närheten dränktes omedelbart i ammoniak. I och med att pumpen var förstörd kunde man inte förhindra fortsatt utsläpp. 10 ton släpptes ut inom de första 3 minuterna. Det enda sättet att stoppa utsläppet var att stänga av en pump manuellt. De enda två gastäta dräkterna användes för att söka rädda de två operatörerna, varför man inte kunde stänga pumpen. Ammoniakångor spreds till kontrollrummet. Operatörerna hann knappt slå larm och sätta igång nödstoppet. De lämnade byggnaden med hjälp av nödutrustningen. Företagets katastrofplan aktiverades inom någon minut. Allmänheten varnades över radio. Då räddningstjänsten anlänt koncentrerade man sig på att söka rädda eventuella saknade. Fem brandmän utan tillräckliga skydd skadades. Efter 40 minuter lyckades man stoppa utsläppet. Gasmolnet skingrades ganska snart.

Inblandade ämnen och mängder

	CAS Nr.	Mängd
flytande vattenfri ammoniak	7664-41-7	38 ton

Skador:

Människor:	Två operatörer avled. Fem brandmän skadades på grund av otillräckligt skydd. Totalt 3000 människor på fabriksområdet utsattes för ammoniak. I omgivningen utsattes 50 000 människor för utsläppet.
Materiella:	Inga.
Miljö/ekologi:	Inga effekter rapporterade.
Infrastruktur:	Inga bortsett från varningar om utsläpp.

Erfarenheter redovisade (Ja/Nej): Ja.

Kortfattat anges förebyggande åtgärder.

Report Profile

Identification of Report:

country: FA **ident key:** 1989_021_01

reported under Seveso I **directive as** major accident **reports:** SHORT+FULL

Date of Major Occurrence: Time of Major Occurrence

start: 1989-07-06 **start:** 15:00:00

finish: finish:

Establishment:

name:

address:

industry: 2001 general chemicals manufacture

Organic Chemical (Manufacturing of NH3, Methanol, Carbon Dioxide, Fertilizers, NaCN

etc)

Seveso II status: not applicable: Yes **art. 6 (notification):** No

art. 7 (MAPP): No

art. 9 (safety report): No

Date of Report:

short: **full:**

Authority Reporting:

name:

address:

Authority Contact:

rep_cont_name:

rep_cont_phone:

rep_cont_fax:

Additional Comments:

a) - not applicable -

b) - not applicable -

c) - not applicable -

d) - not applicable -

e) - not applicable -

Short Report

country: FA **ident key:** 1989_021_01

Accident Types:

release: Yes **explosion:** No

water contamination: No **other:** No

fire: No

description:

ENVIRONMENTAL AND ATMOSPHERIC CONDITIONS:... see Appendix Short Report / description of accident types

Substance(s) Directly Involved:

toxic: Yes **explosive:** Yes

ecotoxic: No **other:** No

flammable: Yes

description:

Anhydrous Liquid Ammonia (C.A.S. CODE: 7664-41-7, E.E.C. CODE: 007-001-00-5): amount involved = 38,000 kg....

see Appendix Short Report / description of substances involved

Immediate Sources of Accident:

storage: No **transfer:** No

process: Yes **other:** No

description:

The accident occurred in an ammonia injector installation of an urea production plant in an organic chemical

industry manufacturing chemicals such as ammonia, methanol, carbon dioxide, fertilizers, sodium cyanide,

acetone, cyanohydrin, meth... see Appendix Short Report / description of immediate sources

Suspected Causes:

plant or equipment: Yes **environmental:** No

human: No **other:** No

description:

INITIATING EVENT AND CONSEQUENCES:... see Appendix Short Report / description of suspected causes

Immediate Effects:

material loss: Yes

human deaths: Yes

human injuries: Yes **community disruption:** Yes

other: No

ecological harm: No

national heritage loss: No

description:

EFFECTS ON PEOPLE:... see Appendix Short Report / description of immediate effects

Emergency Measures taken:

on-site systems: Yes **decontamination:** No

external services: Yes **restoration:** No

sheltering: Yes **other:** No

evacuation: No

description:

INTERNAL TO THE ESTABLISHMENT:... see Appendix Short Report / description of emergency measures taken

Immediate Lessons Learned:

prevention: Yes **other:** No

mitigation: Yes

description:

LESSONS TO PREVENT ANY RECURRENCE OF SIMILAR ACCIDENTS:... see Appendix Short Report / description of immediate lessons learned

A Occurrence Full Report

country: FA **ident key:** 1989_021_01

1 Type of Accident

remarks: The catastrophic failure of an URACA ammonia pump caused the release of liquid ammonia (code 1102), resulting in a flash-evaporation with the formation of a toxic gas cloud (code 1101).

2 Dangerous Substances

remarks: The total establishment and the potential directly involved inventories of anhydrous liquid ammonia refer to the amount released during the accident that is the capacity of the buffer storage vessel (about 10 tonnes released in 3 minutes) p... see Appendix Full Report A / dangerous substances

3 Source of Accident

illustration: - not applicable -

remarks: The accident occurred in an ammonia injector installation of an Urea manufacturing plant in an organic chemical industry (code 2001). The plant produces urea by the interaction of carbon dioxide and anhydrous liquid ammonia with a re-cyclin... see Appendix Full Report A / source of accident - remarks

4 Meteorological Conditions

precipitation none: fog: rain: hail: snow:

No No No No No

wind speed (m/s): 7

direction (from): 60˚90¯

stability (Pasquill): D

ambient temperature (∞C):

remarks: On-site wind speed variable between 12.9˚16.4 mph (5.8˚7.3 m/s). Wind direction variable between 60¯-90¯. The atmospheric stability was assessed as Pasquill category "D".

5 Causes of Major Occurrence

main causes

technical / physical 5104 operation: corrosion/fatigue

- not applicable -

- not applicable -

- not applicable -

- not applicable -

human / organizational 5308 organization: design of plant/equipment/system (inadequate, inappropriate)

5314 organization: testing/inspecting/recording (none, inadequate, inappropriate)

- not applicable -

- not applicable -

- not applicable -

remarks: The crankshaft of the URACA pump failed catastrophically smashing itself through the crackcase. The failure of the crankshaft was due to the propagation of a fatigue crack through the web separating the first and second crank pins (code 510... see Appendix Full Report A / causes of major occurrence

6 Discussion about the Occurrence

- not applicable -

Type of Accident **country:** FA **ident key:** 1989_021_01

event:

major occurrence 1101 release: gas/vapour/mist/etc release to air

initiating event 1102 release: fluid release to ground

associated event - not applicable -

Dangerous substances

country: FA **ident key:** 1989_021_01

a) total establishment inventory

CAS number: 7664-41-7 **identity:** Anhydrous Liquid Ammonia

name from Seveso I Directive: - not applicable -

name from Seveso II Directive: - not applicable -

category from Seveso II: - not applicable -

other hazards (1): - not applicable -

other hazards (2): - not applicable -

maximum quantity (tonnes): 38

use of substance as: STARTING MATERIAL

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 38 **potential quantity:** 38

c) substance belongs to relevant inventory indirectly involved: No

actual quantity: -1 **indir_pot_quant:** -1

Source of Accident - Situation **country:** FA **ident key:** 1989_021_01

situation

industry

inititating event 2001 general chemicals manufacture

associated event - not applicable -

activity/unit

major occurrence 3102 process: chemical continuous reaction

inititating event 3102 process: chemical continuous reaction

associated event - not applicable -

component

major occurrence 4007 machinery/equipment (pump, filter, column seperator, mixer, etc.)

inititating event 4007 machinery/equipment (pump, filter, column seperator, mixer, etc.)

associated event - not applicable -

B Consequences Full Report

country: FA **ident key:** 1989_021_01

1 Area concerned

affected

extent of effects installation: Yes

establishment: Yes

off-site; local: Yes

off-site; regional: No

off-site; transboundary: No

illustration of effects - not applicable -

remarks The ammonia cloud generated by the initial release drifted off-site and remained... see Appendix

Full Report B / area concerned - remarks

2 People

establishment popul. emergency personnel off-site population

total at risk 3000

immediate fatalities 2

subsequent fatalities

hospitalizing injuries 5 4

other serious injuries

health monitoring

remarks Two operators were engulfed in liquid ammonia and immediately overcome by toxic ... see Appendix

Full Report B / people

3 Ecological Harm

pollution/contamination/damage of:

- residential area (covered by toxic cloud) Suspected

- common wild flora/fauna (death or elimination) Suspected

- rare or protected flora/fauna (death or elimination) Suspected

- water catchment areas and supplies for consumption or recreation Suspected

- land (with known potential for long term ecological harm or Suspected

preventing human access or activities)

- marine or fresh water habitat Suspected

- areas of high conservation value or given special protection Suspected

remarks In the Original Report there is no evidence of significant ecological harms.... see Appendix

Full Report B / ecological harm

4 National Heritage Loss

effects on:

- historical sites not applicable **- historic monuments** not applicable

- historic buildings not applicable **- art treasures** not applicable

remarks No data available.

5 Material Loss

establishment losses off site losses

costs (direct costs to operator) (social costs)

in ECU ECU

material losses

response, clean up, restoration

remarks No significant material damages occurred except to the URACA pump.... see Appendix Full Report B

/ material loss

6 Disruption of Community Life

establishment/plant evacuated disabled/unoccupiable destroyed

- nearby residences/hotels No No No

- nearby factories/offices/small shops No No No

- schools, hospitals, institutions No No No

- other places of public assembly No No No

interruption of utilities etc. no / yes duration

- gas No

- electricity No

- water No

- sewage treatment works No

- telecommunications No

- main roads No

- railways No

- waterways No

- air transport No

significant public concern none local level national level

- off site populations No Yes No

- media interest No Yes No

- political interest No No No

remarks The off-site emergency plan was activated within 5 minutes of the start of the r... see Appendix

7 Discussion of Consequences

C Response Full Report

country: FA **ident key:** 1989_021_01

1 Emergency Measures

taken - on site - not applicable - - not applicable -

- not applicable - - not applicable -

- not applicable - - not applicable -

- off site - not applicable - - not applicable -

- not applicable - - not applicable -

- not applicable - - not applicable -

still - on site - not applicable - - not applicable -

required

- not applicable - - not applicable -

- not applicable - - not applicable -

- off site - not applicable - - not applicable -

- not applicable - - not applicable -

- not applicable - - not applicable -

continuing contamination or danger

-on site not applicable

-off site not applicable

remarks - not applicable -

2 Seveso II Duties

pre-accident evaluation

Article item not due yet not done done/submitted evaluated

6 notification No No No No

7 policy (MAPP) No No No No

9 safety report No No No No

9, 10, 11 update No No No No

11 internal plan No No No No

11 external plan No No No No

13 informing public No No No No

9, 12 siting policy No No No No

post-accident evaluation

Seveso II duty was actual were actual compared with actual

contingency consequences consequences, the

addressed? addressed? predicted extent was?

Article item

7 policy (MAPP) not applicable not applicable not applicable

9 current safety report not applicable not applicable not applicable

11 internal plan not applicable not applicable not applicable

11 external plan not applicable not applicable not applicable

13 informing public not applicable not applicable not applicable

9, 12 siting policy not applicable not applicable not applicable

evaluation of safety organisation

organisational element element existed did element relate to actual circumstances of

yes / no no / partly / yes adequate?

- written policy objectives No

- specified management No

structure

- specified responsibilities No

- specified working procedures No

- specified procedures for No

assessment/auditing of

management system

- specified procedures for No

review and update of

management policy

- specified general training No

procedures

- specified emergency No

training procedures

evaluation of ecological impact control

organisational element element existed did element relate to actual circumstances of

yes / no no / partly / yes adequate?

- ecological status review No

before incident

- potential ecological No

consequences assessment

- ecological impact review No

after incident

- ecological restoration No

procedures

- subsequent review of No

restoration success

remarks - not applicable -

3 Official Action Taken

legal action

- not applicable -

other official action

- not applicable -

4 Lessons Learned

measures to prevent recurrence

After the accident, the follow... see Appendix Full Report C / lesson learned - prevent

measures to mitigate consequences:

After the accident, it was est... see Appendix Full Report C / lesson learned - mitigate

useful references:

- not applicable -

5 Discussion about Response

- not applicable -

Appendices for the FA / 1989_021_01 report

Appendix Short Report / description of accident types:

ENVIRONMENTAL AND ATMOSPHERIC CONDITIONS:

On-site wind speed variable between 12.9˜16.4 mph (5.8˜7.3 m/s). Wind direction variable between 60¯-90¯. The atmospheric stability was assessed as Pasquill category "D".

ACCIDENT CASE HISTORY DESCRIPTION:

At 15:30 the crankcase of an URACA horizontal action 3 throw pump, used to boost liquid ammonia pressure from 300 psi to 3,400 psi, was punctured by fragments of the failed pump-ram crankshaft. The two operators investigating the previously reported noises from the pump were engulfed in ammonia and immediately overcome by fumes. Once the pump crackcase was broken, nothing could be done to prevent the release of the contents of the surge drum (10 tonnes were released in the first three minutes). The supply of ammonia from the ring main could only be stopped by switching off the supply pump locally. No one were able to do this as the two gas-tight suits available were preferentially used for search and rescue operations, and thus release of ammonia continued. Ammonia fumes quickly began to enter the plant control room and the operators hardly had the time to sound the alarms and start the plant shut-down before they had to leave the building using 10 minutes escape breathing apparatus sets. During the search and rescue operation the fire authorities did not use the gas-tight suits and fumes entered the gaps around the face piece and caused injuries to 5 men. The

ammonia cloud generated by the initial release drifted off-site and remained at a relatively low level.

Appendix Short Report / description of substances involved:

Anhydrous Liquid Ammonia (C.A.S. CODE: 7664-41-7, E.E.C. CODE: 007-001-00-5): amount involved = 38,000 kg.

N.B. 10,000 kg, the contents of the surge drum, were released in the first three minutes. About 28,000 kg were released in the following 40 minutes until the ammonia ring main was isolated.

Appendix Short Report / description of immediate sources:

The accident occurred in an ammonia injector installation of an urea production plant in an organic chemical industry manufacturing chemicals such as ammonia, methanol, carbon dioxide, fertilizers, sodium cyanide, acetone, cyanohydrin, methyl methacrylate, basic organic chemicals, synthetic resins and plastic materials. The plant manufactures urea by the interaction of carbon dioxide and anhydrous liquid ammonia with a re-cycling carbonate solution. Liquid ammonia, imported from the factory ring main via a buffer storage vessel, was mixed with recycled ammonia and the pressure boosted from 21 bar (300 psi) to 239 bar (3,400 psi) by an Uraca conventional pump before delivery into the reactors. The accident occurred during normal operation. The location of the factory is shown on a map attached to the Original Report.

Appendix Short Report / description of suspected causes:

INITIATING EVENT AND CONSEQUENCES:

The catastrophic failure of an URACA liquid ammonia pump caused the release of pressurized liquid ammonia. The initial release of 10 tonnes in the first 3 minutes (the contents of the surge drum) was followed by 28 tonnes in the subsequent 40 minutes until the ammonia ring main was isolated.

CAUSES:

The crankshaft of the Uraca pump failed catastrophically smashing itself through the crankcase. Failure of the crankshaft was due to to the propagation of a fatigue crack through the web separating the first and second crank pins. Metallurgical investigations found no initiating defect leading to crack propagation. It is thought that the failure was due to some overload of the web/crank pin radius at some unknown time. No inspections were foreseen for this component.

Appendix Short Report / description of immediate effects:

EFFECTS ON PEOPLE:

3,000 on-site people were exposed. 2 operators were immediately killed by the toxic release (they were investigating previously reported noises from the pump when the leak happened and they were surrounded by fumes). 5 members of the fire brigades were injured by ammonia because they did not use gas-tight suits and fumes entered the gaps around the face pieces of the suits.

About 50,000 off-site people were exposed to the fumes (up to 7 km away) but nobody was seriously affected.

MATERIAL LOSS:

No significant material damages occurred except to the URACA pump.

OUTSIDE THE ESTABLISHMENT

The ammonia cloud generated by the initial release drifted off-site and remained at a relatively low-level. On the basis of the described effects and of post accident predictions, it was evaluated that ammonia concentration was about 150 ppm for 10 minutes at 3.5 km reducing to 50 ppm for 15 minutes at 7 km from the leak source. On a map attached to the Original Report is shown the path made by the toxic cloud vs the time from the beginning of the accident.

Local radio warnings were given but this was too late for some local schools. Some mothers and children were affected while making their way home (the accident occurred at about 15:30).

Appendix Short Report / description of emergency measures taken:

INTERNAL TO THE ESTABLISHMENT:

The operators of the plant control room, before to leave the building using 10 minutes escape breathing apparatus sets because ammonia fumes began to enter the room, hardly had time to sound the alarms and to start the plant shut-down. The on-site emergency plan was activated within minutes of the alarm being sounded. A roll call quickly established that only 2 men were missing and a decision was made to use the 2 gas-tight suits for search and rescue in preference to isolate the ammonia ring main supply.

EXTERNAL TO THE ESTABLISHMENT:

The off-site emergency plan was activated within 5 minutes of the start of the release. Local radio warnings were given but this was too late for some local schools and some mothers and children were affected while making their way home.

Appendix Short Report / description of immediate lessons learned:

LESSONS TO PREVENT ANY RECURRENCE OF SIMILAR ACCIDENTS:

After the accident, the following measures were established:

1- existing similar pumps to be thoroughly examined and fitted with crankshaft deflection devices;

2- older design crankshafts to be replaced with new crankshafts (differences in the material of construction and crank pin radius);

3- critical plant machineries to be identified and subjected to a regime of inspection similar to that applied to pressure vessels.

LESSONS TO MITIGATE THE CONSEQUENCES OF SIMILAR ACCIDENTS:

After the accident, it was established that automatic remotely operated shut-off valves have to be fitted to liquid ammonia supply systems so that a hazardous piece of the plant can be isolated quickly and the amount of the ammonia (eventually released in case of an accident) reduced.

Appendix Full Report A / dangerous substances:

The total establishment and the potential directly involved inventories of anhydrous liquid ammonia refer to the amount released during the accident that is the capacity of

the buffer storage vessel (about 10 tonnes released in 3 minutes) plus the amount, relased in the following 40 minutes (about 28 tonnes), coming from the factory ring main.

Appendix Full Report A / source of accident - remarks:

The accident occurred in an ammonia injector installation of an Urea manufacturing plant in an organic chemical industry (code 2001). The plant produces urea by the interaction of carbon dioxide and anhydrous liquid ammonia with a re-cycling carbonate solution (code 3102). The liquid ammonia, imported from the factory ring main via a buffer storage vessel, was mixed with recycled ammonia and pressure boosted from 300 psi to 3,400 psi by a URACA pump (code 4007) before delivery to the reactors.

Appendix Full Report A / causes of major occurrence:

The crankshaft of the URACA pump failed catastrophically smashing itself through the crackcase. The failure of the crankshaft was due to the propagation of a fatigue crack through the web separating the first and second crank pins (code 5104). Metallurgical examination have not found initiating defects leading to crack propagation (failure was probably due to overload of the web/crank pin). No inspections were foreseen for this component (code 5314). The pump design was not adequate (code 5308).

Appendix Full Report B / area concerned - remarks:

The ammonia cloud generated by the initial release drifted off-site and remained at a relatively low level. On the basisi of the effects described and of post accident predictions, it was evaluated that ammonia concentration was about 150 ppm for 10 minutes at 3.5 km reducing to 50 ppm for 15 minutes at 7 km. On the map attached to the Original Report is shown the path made by the toxic cloud vs the time from the beginning of the accident.

Appendix Full Report B / people:

Two operators were engulfed in liquid ammonia and immediately overcome by toxic fumes. 4 members of the fire brigades were injured by ammonia because they did not use gas-tight suits and fumes entered the gaps around the face pieces of the suits. A substantial number of people complained about the fumes (up to 7 Km away) but nobody was seriously affected. Some mothers and children were affected by fumes while making their way home.

Appendix Full Report B / ecological harm:

In the Original Report there is no evidence of significant ecological harms.

Appendix Full Report B / material loss:

No significant material damages occurred except to the URACA pump.

Appendix Full Report B / disruption of community life:

The off-site emergency plan was activated within 5 minutes of the start of the release. Local radio warned off-site population.

Appendix Full Report C / lesson learned - prevent:

After the accident, the following measures were established:

1- existing similar pumps to be thoroughly examined and fitted with crankshaft deflection devices;

2- older design crankshafts to be replaced with new crankshafts (differences in the material of construction and crank pin radius);

3- critical plant machineries to be identified and subjected to a regime of inspection similar to that applied to pressure vessels.

Appendix Full Report C / lesson learned - mitigate:

After the accident, it was established that automatic remotely operated shut-off valves have to be fitted to liquid ammonia supply systems so that a hazardous piece of the plant can be isolated quickly and the amount of the ammonia (eventually released in case of an accident) reduced.