Explosion till följd av hexanutsläpp i en anläggning för tillverkning av råvaror till livsmedelsindustri.

800715 MARS 1800_012_001

I samband med igångkörning (21:30) efter ett produktionsstopp i en extraktionsanläggning började hexan läcka genom en klaffventil ut i fabriksbyggnaden. De anställda reagerade inte till en början eftersom det inte var ovanligt att känna lukten av hexan i samband med uppstart. Hexanhalten steg i fabrikslokalen till dess att personalen i fabriken nödgades lämna lokalen (23:35). Strax före midnatt noterade en förbiåkande busschaufför att det lukatde hexan utanför anläggningen. 00:15 tog sig personalen till grinden och kallade in ledig personal inklusive driftschefen. Busschauffören som åter passerade stoppades och larmade brandkår och polis. Brandkåren anlände 00:25. Driftschefen anlände 00:35 och gick in i byggnaden där läckaget fanns och lokaliserade det. Driftschefen beslöt tillsammans med brandkåren att stänga av all elektricitet på fabriken. I samband med att en transformator stängdes av antändes hexangasen och explosionen inträffade.

Inblandade ämnen och mängder

	CAS Nr.	Mängd
Hexan	110-54-3	15 ton

Skador:

Människor:	27 personer (anställda, brandmän och poliser) skadades vid explosionen
Materiella:	Fabriken, med sex byggnader totalförstördes. Utanför fabriksområdet krossades fönster upp till 1500 meter bort.
Miljö/ekologi:	Inga skador rapporterade.
Infrastruktur:	Inga skador rapporterade.

Erfarenheter redovisade (Ja/Nej): Ja

Se rapporten "Ekplosionsulykken pa Dansk Sojakagefabrik" 1980, 15 juli.

Report Profile

Identification of Report:

country: FA **ident key:** 1800_012_01

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

Date of Major Occurrence: Time of Major Occurrence

start: 15/07/1980 **start:** 01:00:00

finish: finish:

Establishment:

name:

address:

industry: 2001 general chemicals manufacture

Raw Materials for the Food Industry and Farmers

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:** 1800_012_01

Accident Types:

release: Yes **explosion:** Yes

water contamination: No **other:** No

fire: No

description:

SAFETY SYSTEMS OR OPERATORS INTERVENTION:... see Appendix Short Report / description of accident types

Substance(s) Directly Involved:

toxic: No **explosive:** Yes

ecotoxic: No **other:** No

flammable: Yes

description:

- Hexane (C.A.S. CODE:110-54-3): amount involved = 15,000 kg.

Immediate Sources of Accident:

storage: No **transfer:** No

process: Yes **other:** No

description:

The accident occurred during the start-up of an extractor in a factory manufacturing raw materials for the

food industry and farmers. A detailed description of the system with semplified flow-sheets is attached to the

Original Report.

Suspected Causes:

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

human: Yes **other:** No

description:

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

Immediate Effects:

material loss: Yes

human deaths: No

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: No **other:** No

evacuation: Yes

description:

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

Immediate Lessons Learned:

prevention: Yes **other:** Yes

mitigation: No

description:

After this accident, it has been decided that this plant will not be rebuilt.... see Appendix Short Report /

description of immediate lessons learned

A Occurrence Full Report

country: FA **ident key:** 1800_012_01

1 Type of Accident

remarks: A leakage of hexane from a flap valve occurred during the start-up of an

extractor (code 1101). Due to the failure of an interlocking system in

cut-off the hexane flow to the toaster connected with the extractor, the

concentration of hexane... see Appendix Full Report A / type of accident

2 Dangerous Substances

remarks: The total establishment and the potential directly involved inventories of

hexane refer to the amount involved in the accident. From the Original

Report is not fully clear if hexane was a starting material or a finished

product.

3 Source of Accident

illustration: - not applicable -

remarks: The accident occurred during the start-up of an extractor (codes 3302 and

4012) in a factory manufacturing raw materials for the food industry and farmers (code 2001). A detailed description of the system with simplified flow-sheets is atta... 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):

direction (from):

stability (Pasquill):

ambient temperature (∞C):

remarks: Not relevant for the accident.

5 Causes of Major Occurrence

main causes

technical / physical 5105 operation: instrument/control/monitoring-device failure

- not applicable -

- not applicable -

- not applicable -

- not applicable -

human / organizational 5303 organization: organized procedures (none, inadequate, inappropriate, unclear)

5401 person: operator error

- not applicable -

- not applicable -

- not applicable -

remarks: The leakage of hexane was due to the incorrect operation of the safety flap valve caused by the malfunctioning of the interlocking system (code 5105) to cut-off the steam and hexane flows to the toasters and one of the two outlet conveyor w... see Appendix Full Report A / causes of major occurrence

6 Discussion about the Occurrence

- not applicable -

Type of Accident **country:** FA **ident key:** 1800_012_01

event:

major occurrence 1307 explosion: VCE (vapour cloud explosion; supersonic wave front)

initiating event 1101 release: gas/vapour/mist/etc release to air

associated event - not applicable -

Dangerous substances

country: FA **ident key:** 1800_012_01

a) total establishment inventory

CAS number: 110-54-3 **identity:** Hexane

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): 15

use of substance as: NORMAL FINISHED PRODUCT

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 15 **potential quantity:** 15

c) substance belongs to relevant inventory indirectly involved: No

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

Source of Accident - Situation **country:** FA **ident key:** 1800_012_01

situation

industry

inititating event 2001 general chemicals manufacture

associated event - not applicable -

activity/unit

major occurrence 3302 transfer: mechanical transfer (conveyors, etc.)

inititating event 3302 transfer: mechanical transfer (conveyors, etc.)

associated event - not applicable -

component

major occurrence 4012 other transfer equipment/apparatus/vehicle

inititating event 4012 other transfer equipment/apparatus/vehicle

associated event - not applicable -

B Consequences Full Report

country: FA **ident key:** 1800_012_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 plant was totally destroyed by the explosion and, outside the establishment,... see Appendix

Full Report B / area concerned - remarks

2 People

establishment popul. emergency personnel off-site population

total at risk

immediate fatalities

subsequent fatalities

hospitalizing injuries 27

other serious injuries

health monitoring

remarks 27 people (staff members, firemen and police officers) were injured by the explo... 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 The plant (6 buildings) was totally destroyed by the explosion and, outside the ... 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 No No

- political interest No No No

remarks Outside the establishment the windows were broken up to a distance of 1.5 Km.... see Appendix Ful

7 Discussion of Consequences

C Response Full Report

country: FA **ident key:** 1800_012_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 this accident, it has be... see Appendix Full Report C / lesson learned - prevent

measures to mitigate consequences:

- not applicable -

useful references:

More detailed information abou... see Appendix Full Report C / lesson learned - references

5 Discussion about Response

- not applicable -

Appendices for the FA / 1800_012_01 report

Appendix Short Report / description of accident types:

SAFETY SYSTEMS OR OPERATORS INTERVENTION:

Sprinkler system was automatically activated at 55ˆ60¯C.

ACCIDENT CASE HISTORY DESCRIPTION:

On July 14, maintenance works were completed and, after the inspection by the plant operator, the start-up of the facility was initiated at 21:30. Steam was admitted to the toaster and to the jackets of hexane/miscella inlet pipes to heat-up the toasters and the extractor to the proper operating temperatures. At about 21:45 the toasters reached their operating temperature and admittance of flakes commenced through the inlet screw conveyor. Afterthat, the following events occurred (the time shown had been approximately evaluated on instrument readings and information from the staff, as no log was in operation) until the explosion took place at 00:47:

- 22:45ˆ23:00: The night shift took over and at the same time the first flakes dropped from the outlet screw conveyor into the toasters.

- 23:15: The toaster temperature dropped to 85¯C. The plant operator therefore opened fully for the steam flow to the toaster jackets and the upper parts (direct steam) of the toasters. About the same time the safety flap valve was heard lifting releasing hexane and steam into the extractor building, where the smell of hexane was detected by the operators. This was, however, not an abnormal occurrence during the start-up.

- 23:25: One of the flake outlet conveyors stopped due to overloading and the interlocking system stopped the flake inlet conveyor and the internal belt conveyor but not the other outlet conveyor nor the steam and hexane flows. High hexane concentrations were detected in the extractor building. The plant operator, however, was of the opinion that the steam and hexane flows were stopped according to the operation procedure.

- 23:35: The flake outlet conveyor was restarted and the operating staff began to search for the hexane release point but without success. The hexane concentration in the extraction building finally reached a level which forced the staff out of the extractor building.

- 23:55: A bus driver passing the facility detected the hexane vapours and about the same time the sprinkler system below the extractor was activated by the released hot hexane/steam mixture.

- 00:15: The operating staff left the facility and from the Gate called in assistance of staff which were not on duty, including the chief plant operator (CPO). At the same time they stopped the above mentioned bus driver, when he was to pass again warning him against the possible danger. The bus driver informed the Traffic Control Center, which in turn alarmed the Police and the Fire Brigade.

- 00:25: The first Fire Brigade unit arrived and decided to call in further assistance.

- 00:35: The Chief Plant Operator (CPO) and the Fire Inspector on Duty arrived. The CPO went into the extractor building and located the leak to the safety flap, from which gas/liquids clearly appeared.

- 00:40˜00:45: The CPO and the Fire Inspector discussed how to stop the outflow of hexane vapours and decided to do this by cutting off the power supply. They called the power plant engineer and asked him to do it. Due to the inherent risk of possible sparks he rejected to stop the loaded transformers and instead, for unknown reasons, disconnected a third unloaded transformer at about 00:47.

- 00:47.30: A fire seen in the far end of the extractor yard was spotted followed by a strong explosion injuring 27 persons (staff members, firemen and police officers) and damaging completely 6 buildings.

Appendix Short Report / description of suspected causes:

INITIATING EVENT AND CONSEQUENCES:

Seed overpressure in the extractor lifted and relocated flap valve preventing reclosing. Based on the investigations carried out, it has been concluded that excessive amounts of steam leaking from the toaster to the extractor led to lifting and relocating of the safety flap valve. The steam leaking from the toaster to the extractor occurred due to lack of flakes in the outlet screw conveyors, which acted as a barrier against steam/gas flow. As a consequence, hexane was released and led to an explosion. Based on the available information it seems clear that the explosion was initiated by the disconnection of a transformer which ignited the hexane cloud.

CAUSES

The leakage of hexane (flammable/explosive gas) was due to the incorrect operation of the safety flap valve caused by the failure of the interlocking system to cut-off the steam and hexane flows to the toaster when one of the extractor outlet conveyors was stopped. An unloaded transformer, disconnected by mistake just before the explosion, it is believed to have caused the ignition of the hexane vapours cloud.

Appendix Short Report / description of immediate effects:

EFFECTS ON PEOPLE:

27 people (staff members, firemen and police officers) were injured by the explosion.

MATERIAL LOSS:

The plant (6 buildings) was totally destroyed by the explosion and, outside the establishment, the windows were broken up to a distance of 1.5 Km. No data are available about the cost of thee damages.

COMMUNITY DISRUPTION:

Outside the establishment the windows were broken up to a distance of 1.5 Km.

Appendix Short Report / description of emergency measures taken:

INTERNAL TO THE ESTABLISHMENT:

Evacuation of the extractor building. After the identification of leakage source, some methods for stopping the hexane leakage have been evaluated but the explosion occurred before any action could be carried out.

EXTERNAL TO THE ESTABLISHMENT:

The fire brigade and the police were alarmed by a bus driver who smelt hexane vapours outside the plant and was informed by the operating staff for the possible danger. The police barred the area and the fire brigade were preparing for action when the explosion occured. Approximately 20 people of police and fire brigade personnel were mobilized.

Appendix Short Report / description of immediate lessons learned:

After this accident, it has been decided that this plant will not be rebuilt.

MEASURES TO PREVENT ANY RECURRENCE OF SIMILAR ACCIDENTS:

Following a visit of an expert group set up in France to establish new Safety Guidelines for extraction facilities in 1985, the following conclusions and recommendations have been considered for preventing similar accidents:

1- release of gas from the safety flap must occur in a safe location;

2- improvements for the design of the extractor building and its ventilation system would be necessary;

3- improvements of the safety and interlock systems;

4- improvements of gas detection and fire protection systems;

5- improvement of the safety management.

Appendix Full Report A / type of accident:

A leakage of hexane from a flap valve occurred during the start-up of an extractor (code 1101). Due to the failure of an interlocking system in cut-off the hexane flow to the toaster connected with the extractor, the concentration of hexane vapours inside the building rose.The hexane vapour cloud was finally ignited by the disconnection of a

transformer, resulting in an explosion (code 1307).

Appendix Full Report A / source of accident - remarks:

The accident occurred during the start-up of an extractor (codes 3302 and 4012) in a factory manufacturing raw materials for the food industry and farmers (code 2001). A detailed description of the system with simplified flow-sheets is attached to the Original report.

Appendix Full Report A / causes of major occurrence:

The leakage of hexane was due to the incorrect operation of the safety flap valve caused by the malfunctioning of the interlocking system (code 5105) to cut-off the steam and hexane flows to the toasters and one of the two outlet conveyor when the second flake outlet conveyor stopped due to overloading. It resulted in an overpressure inside the extractor and in the flap valve opening. The hexane vapours cloud was ignited during the erroneous disconnection of a transformer (codes 5303 and 5401).

Appendix Full Report B / area concerned - remarks:

The plant was totally destroyed by the explosion and, outside the establishment, the windows were broken up to a distance of 1.5 Km.

Appendix Full Report B / people:

27 people (staff members, firemen and police officers) were injured by the explosion of the hexane vapours cloud. From the Original Report is not fully clear if they were hospitalized or not.

Appendix Full Report B / ecological harm:

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

Appendix Full Report B / material loss:

The plant (6 buildings) was totally destroyed by the explosion and, outside the establishment, the windows were broken up to a distance of 1.5 Km. No data are available about the cost of the damages.

Appendix Full Report B / disruption of community life:

Outside the establishment the windows were broken up to a distance of 1.5 Km.

Appendix Full Report C / lesson learned - prevent:

After this accident, it has been decided that this plant will not be rebuilt.

Following a visit of an expert group set up in France to establish new safety Guidelines for extraction facilities in 1985, the following conclusions and recommendations have been considered for preventing similar accidents:

1- release of gas from the safety flap valve must occur in a safe location;

2- improvements for the design of the extractor building and its ventilation system would be necessary;

3- improvements of the safety and interlock systems;

4- improvements of gas detection and fire protection systems;

5- improvement of the safety management.

Appendix Full Report C / lesson learned - references:

More detailed information about the accident are contained in the document "Ekplosionsulykken pa Dansk Sojakagefabrik" of July 15, 1980.