Explosion och brand i en fabrik för produktion av pesticider.

901210 MARS 1800_17

En ny reaktor för produktion av MP-2 (se nedan) användes för första gången. Den nya reaktorn var mikroprocessorstyrd för kontroll av tillsatsen av klor, och av kylningen för att kontrollera reaktionsbetingelserna, 30 grader och atmosfärstryck. Kloreringen av MP-2 är värmeutvecklande. Under testkörning sattes temperaturkontrollen ur spel vilket förbisågs vid igångkörningen. På grund av en hög tillsatshastighet av klor och frånvaro av kylning steg temperaturen till 120 grader efter 2 timmar. Trycket var vid det laget uppskattningvis 25-35 bar. Snabba nedbrytningsreaktioner ledde till att reaktionskärlet sprack. Eldfarliga gaser slapp ut i fabrikslokalen och antändes när de nådde kontrollrummet. Företagets interna brandkår bekämpade elden framgångsrikt, assisterade av räddningstjänsten.

Inblandade ämnen och mängder

	CAS Nr.	Mängd
Explosionen		
0,0-dimethyl-phosphoro-dithioic acid [MP-1]	756-80-9	sammanlagt ca 1 ton MP-1, MP-2, och MP-3
0,0-dimethyl-phosphoro-chloridothioate [MP-2]	2524-03-0	
Thioperoxydiphosphoric acid tetramethyl ester [MP-11]	5930-71-2	
Branden		
Methylchloride	74-87-3	115 kg
diverse metylsulfider - huvudsakligen dimetylsulfid	624-92-0	250 kg
diverse svavel och fosforföreningar		okänt
nafta	8030-30-6	
väteklorid	7647-01-0	1000 kg

Skador:

Människor:	Sex arbetare fabriken skadades lindrigt vid explosionen och fick tillbringa tid på sjukhus för observation.
Materiella:	Anläggingen skadades. Kostnaden uppskattas till ca 1,9 MECU.
Miljö/ekologi:	Inga rapporterade.
Infrastruktur:	Inga.

Erfarenheter redovisade (Ja/Nej): Ja

Ombyggnad och modifiering av anläggningen, särskilt med avseende på rutinerna för test- och igångkörning.

Report Profile

Identification of Report:

country: FA **ident key:** 1800_017_01

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

Date of Major Occurrence: Time of Major Occurrence

start: 10/12/1990 **start:** 17:00:00

finish: finish:

Establishment:

name:

address:

industry: 2004 pesticides, pharmaceuticals, other fine chemicals

Pesticide (Process plant)

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_017_01

Accident Types:

release: Yes **explosion:** Yes

water contamination: No **other:** No

fire: No

description:

Plant description:... see Appendix Short Report / description of accident types

Substance(s) Directly Involved:

toxic: Yes **explosive:** Yes

ecotoxic: No **other:** No

flammable: Yes

description:

SUBSTANCES INVOLVED IN THE EXPLOSIONS:... 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 a facility for chlorination (used in the production of

0,0-dimethyl-phosphorochloridothioate [MP-2] and 0,0-diethyl-phosphorochloridothioate [EP-2]) of a pesticide

industry. The component involved was a new chlorina... see Appendix Short Report / description of immediate

sources

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:** No

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: 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:

INTERNAL TO THE ESTABLISHMENT:... see Appendix Short Report / description of immediate lessons learned

A Occurrence Full Report

country: FA **ident key:** 1800_017_01

1 Type of Accident

remarks: The accident occurred when a new chlorination unit reactor was used for the

first time. Owing to a high chlorine addition rate and no cooling, the

temperature rose to be beyond the normal operating conditions causing a

sudden fast decomposi... see Appendix Full Report A / type of accident

2 Dangerous Substances

remarks: The whole amount of MP-1 (0,0-dimethyl-phosphorodithioic acid), MP-2 (0,0-dimethyl-phosphorochloridothioate) and MP-11 (Thioperoxydiphosphoric acid, tetramethyl ester) involved in the explosions has been estimated in about 1,000 Kg. No data... see Appendix Full Report A / dangerous substances

3 Source of Accident

illustration: - not applicable -

remarks: The accident occurred in a facility for chlorination (used in the production of 0,0-dimethyl-phosphorochloridothioate [MP-2] and 0,0-diethyl-phosphorochloridothioate [EP-2]) of a pesticide industry (code 2004). The component involved was a ... 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): 10

direction (from): N-E

stability (Pasquill):

ambient temperature (∞C):

remarks: The wind (from North East) speed was 8˜10 m/sec.

5 Causes of Major Occurrence

main causes

technical / physical 5106 operation: runaway reaction

- not applicable -

- not applicable -

- not applicable -

- not applicable -

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

5304 organization: training/instruction (none, inadequate, inappropriate)

5307 organization: process analysis (inadequate, incorrect)

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

5401 person: operator error

remarks: Prior to start the production, the temperature sensor (blocked while testing the microprocessor) was not re-connected when the computer was used for process control (codes 5303, 5304 and 5401). Process temperature was not otherwise supervis... see Appendix Full Report A / causes of major occurrence

6 Discussion about the Occurrence

- not applicable -

Type of Accident **country:** FA **ident key:** 1800_017_01

event:

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

initiating event - not applicable -

associated event - not applicable -

event:

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

initiating event 1304 explosion: runaway reaction explosion (usually exothermic)

associated event - not applicable -

Dangerous substances

country: FA **ident key:** 1800_017_01

a) total establishment inventory

CAS number: identity: Sulphurous/phoshorous Compound

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): -1

use of substance as: ABNORMAL PRODUCT

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: -1 **potential quantity:** -1

c) substance belongs to relevant inventory indirectly involved: No

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

a) total establishment inventory

CAS number: 8030-30-6 **identity:** Naphtha E60

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): 1

use of substance as: STARTING MATERIAL

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 1 **potential quantity:** 1

c) substance belongs to relevant inventory indirectly involved: No

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

a) total establishment inventory

CAS number: 74-87-3 **identity:** Methylchloride

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): 0,115

use of substance as: ABNORMAL PRODUCT

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 0,115 **potential quantity:** -1

c) substance belongs to relevant inventory indirectly involved: No

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

a) total establishment inventory

CAS number: 2524-03-0 **identity:** M P-2

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): 1

use of substance as: NORMAL FINISHED PRODUCT

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 1 **potential quantity:** 1

c) substance belongs to relevant inventory indirectly involved: No

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

a) total establishment inventory

CAS number: 5930-71-2 **identity:** M P-11

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): 1

use of substance as: NORMAL FINISHED PRODUCT

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 1 **potential quantity:** 1

c) substance belongs to relevant inventory indirectly involved: No

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

a) total establishment inventory

CAS number: 756-80-9 **identity:** M P-1

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): 1

use of substance as: STARTING MATERIAL

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 1 **potential quantity:** 1

c) substance belongs to relevant inventory indirectly involved: No

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

a) total establishment inventory

CAS number: 7647-01-0 **identity:** Hydrogen Chloride

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): -1

use of substance as: STARTING MATERIAL

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: -1 **potential quantity:** -1

c) substance belongs to relevant inventory indirectly involved: No

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

a) total establishment inventory

CAS number: 624-92-0 **identity:** Dimethyldisulfide

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): 0,25

use of substance as: ABNORMAL PRODUCT

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 0,25 **potential quantity:** -1

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_017_01

situation

industry

inititating event 2004 pesticides, pharmaceuticals, other fine chemicals

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 4001 reaction vessel; non-pressurised

inititating event 4001 reaction vessel; non-pressurised

associated event - not applicable -

B Consequences Full Report

country: FA **ident key:** 1800_017_01

1 Area concerned

affected

extent of effects installation: Yes

establishment: No

off-site; local: No

off-site; regional: No

off-site; transboundary: No

illustration of effects - not applicable -

remarks On the basis of the deformations of the reactor and of the damages to the buildi... see Appendix

Full Report B / area concerned - remarks

2 People

establishment popul. emergency personnel off-site population

total at risk 26 13

immediate fatalities

subsequent fatalities

hospitalizing injuries

other serious injuries 6

health monitoring

remarks 6 people inside the establishment were injured by the explosion and they were ho... 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 DKR ECU DKR

material losses 1,4E+07

response, clean up, restoration

remarks The process building, the control room, the process and control equipment were h... 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 Yes No No

- media interest No No No

- political interest No No No

remarks In the Original Report there is no evidence of significant effects outside the p... see Appendix

7 Discussion of Consequences

C Response Full Report

country: FA **ident key:** 1800_017_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, the follo... see Appendix Full Report C / lesson learned - prevent

measures to mitigate consequences:

The buildings, the process and... see Appendix Full Report C / lesson learned - mitigate

useful references:

- not applicable -

5 Discussion about Response

- not applicable -

Appendices for the FA / 1800_017_01 report

Appendix Short Report / description of accident types:

Plant description:

Facility for chlorination used in the production of 0,0-dimethyl-phosphorochloridothioate (MP-2) and 0,0-diethyl-phosphorochloridothioate (EP-2).

A new reactor for production of 0,0-dimethyl-phosphorochloridothioate (MP-2) was used for the first time. Similar equipment was already in use for the same production but the new reactor was microprocessor controlled, especially for controlling the chlorine addition rate and the cooling in order to maintain the process conditions (30¯C and atmospheric pressure) because the chlorination of 0,0-Dimethyl-phosphorodithiotic acid (MP-1) to MP-2 is exothermic.The reaction took place in extraction naphtha (E-60). By-products were thioperoxy-diphosphoric acid tetramethyl ester (MP-11), hydrogen chloride and sulphur.

During commissioning, the temperature controller was blocked while testing the microprocessor and the connection was not re-established before starting operation. The production started at noon and the operators did not paid attention to the temperature that was recorded. Owing to a high chlorine addition rate and no cooling, the temperature rose to be in excess of 120¯C about 2 hours after the production started. The solvent (naphta) evaporated and a sudden fast decomposition occurred at 17:55. This resulted in fracture of the rupture disc, in deformation of the reactor lid and in elongation of the bolts of the lid. Flammable gasses were released through the venting system and through the opened reactor lid into process hall. The vapour cloud was ignited when it reached the control room causing an explosion. On the basis of the deformations of the reactor and of the building, Cheminova Agro estimated that the pressure in the reactor reached values of 25ˆ35 bar and that the overpressure in the building reached values of 100ˆ150 mbar. The fire was extinguished by the internal fire brigade assisted by the local fire brigade.

Appendix Short Report / description of substances involved:

SUBSTANCES INVOLVED IN THE EXPLOSIONS:

- 0,0-dimethyl-phosphorodithioic acid [MP-1] (C.A.S. CODE: 756-80-9).

- 0,0-dimethyl-phosphorochloridothioate [MP-2] (C.A.S. CODE: 2524-03-0).

- Thioperoxydiphosphoric acid tetramethyl ester [MP-11] (C.A.S. CODE: 5930-71-2).

The whole amount of MP-1, MP-2 and MP-11 involved in the explosions has been estimated in about 1,000 Kg. No data are available about the single amounts of MP-1, MP-2 and MP-11.

SUBSTANCES INVOLVED IN THE FIRE:

- Methylchloride (C.A.S. CODE: 74-87-3, E.E.C. CODE: 602-001-00-7): amount involved = 115 Kg.

- Various Methylsulfides (mainly Dimethyldisulfide [C.A.S. CODE: 624-92-0]): amount involved =250 Kg.

- Various Sulphurous/Phosphorous Compounds: amount involved = not known.

- Naphtha [E60] (C.A.S. CODE: 8030-30-6) and Hydrogen Chloride (C.A.S. CODE: 7647-01-0, E.E.C. CODE: 017-002-00-2): amount involved = 1,000 Kg.

Appendix Short Report / description of immediate sources:

The accident occurred in a facility for chlorination (used in the production of 0,0-dimethyl-phosphorochloridothioate [MP-2] and 0,0-diethyl-phosphorochloridothioate [EP-2]) of a pesticide industry. The component involved was a new chlorination reactor used for the first time and controlled by means of a microprocessor. The operating conditions were 30¯C and atmospheric pressure.

Appendix Short Report / description of suspected causes:

INITIATING EVENT AND CONSEQUENCES:

The temperature in the reactor increased beyond 30¯C due to too fast addition of chlorine and lack of cooling. The solvent E-60 evaporated and, when the temperature reached the decomposition value for MP-1, MP-2 and MP-11, a sudden fast decomposition occurred, resulting in deformation, opening of the reactor and then release of flammable gases inside the building and control room. The gases were then ignited and an explosion occurred.

CAUSES:

Prior to start the production, the temperature sensor was blocked while testing the microprocessor. The connection was not re-established when the computer was used for process control in the production of MP-2. Process temperature was not otherwise supervised by the operators, although the temperature automatically was recorded. Due to the lack of temperature control, a sudden fast decomposition of MP-1, MP-2 and MP-11 occurred, resulting in deformation, opening of the reactor and then release of flammable gases inside the process building and control room. The reactor was equipped with a venting system and a relief pipe provided with a rupture disc but the relief capacity of the system was however insufficient compared to the amount of gases released during the fast decomposition of the substances. The gases were ignited and an explosion occurred. The electrical installations in the control room may have been the source of ignition. Investigations indicate that an explosion took place in the control room and in the opinion of Cheminova initiated the explosion in the process building.

Appendix Short Report / description of immediate effects:

EFFECTS ON PEOPLE:

6 people inside the establishment were injured by the explosion (they were hospitalized but for observation only).

MATERIAL LOSS:

The process building, the control room, the process and control equipment were heavily damaged during the accident. The cost of the damages has been evaluated in about 15 millions DKR (about 1.9 MECU).

Appendix Short Report / description of emergency measures taken:

INTERNAL TO THE ESTABLISHMENT:

The internal fire brigade (20 people) extinguished the fire assisted by the local fire brigade.

EXTERNAL TO THE ESTABLISHMENT:

The fire brigade of the small town Thyboroen (12 people) assisted the internal fire brigade. A physician from Thyboroen provided first aid to the 6 operators who were exposed to the explosion.

Appendix Short Report / description of immediate lessons learned:

INTERNAL TO THE ESTABLISHMENT:

The buildings, the process and control equipment will be rebuilt and modified.

MEASURES TO PREVENT ANY RECURRENCE OF SIMILAR ACCIDENTS:

After this accident, the following measures were established:

1- the emergency shut-down system to be independent from the unit (operation) control system;

2- redundancy in the control system to be provided;

3- process supervision (warning/alarm) signals to be improved;

4- temperature and chlorine addition rate control systems to be improved;

5- safety management system to be improved;

6- man-machine communication system to be improved.

MEASURES TO MITIGATE THE EFFECTS OF THE ACCIDENT:

After this accident, it was established that the control room structure should be strengthened and direct access from the production hall to it had to be eliminated.

Appendix Full Report A / type of accident:

The accident occurred when a new chlorination unit reactor was used for the first time. Owing to a high chlorine addition rate and no cooling, the temperature rose to be beyond the normal operating conditions causing a sudden fast decomposition of the substances contained (code 1304). It caused the reactor's rupture and the release of flammable gases (code 1101) into the process hall that were then ignited in the control room, resulting in an unconfined vapour cloud explosion (code 1307).

Appendix Full Report A / dangerous substances:

The whole amount of MP-1 (0,0-dimethyl-phosphorodithioic acid), MP-2 (0,0-dimethyl-phosphorochloridothioate) and MP-11 (Thioperoxydiphosphoric acid, tetramethyl ester) involved in the explosions has been estimated in about 1,000 Kg. No data are available about the single amounts of MP-1, MP-2 and MP-11. Methylchloride, various methylsulfides (main component was dimethyldisulfide) and various sulphurous/phosphorous compounds were obtained by the explosive decomposition of MP-1, MP-2 and MP-11.

Appendix Full Report A / source of accident - remarks:

The accident occurred in a facility for chlorination (used in the production of 0,0-dimethyl-phosphorochloridothioate [MP-2] and 0,0-diethyl-phosphorochloridothioate [EP-2]) of a pesticide industry (code 2004). The component involved was a new chlorination reactor used for the first time and controlled by means of a microprocessor (codes 3101 and 4001). The operating conditions were 30¯C and atmospheric pressure (code 4001).

Appendix Full Report A / causes of major occurrence:

Prior to start the production, the temperature sensor (blocked while testing the microprocessor) was not re-connected when the computer was used for process control (codes 5303, 5304 and 5401). Process temperature was not otherwise supervised by the operators and a runaway explosion occurred in the reactor (code 5106). As the relief capacity of the venting system was insufficient (codes 5307 and 5308), the explosion deformed the reactor lid.

Appendix Full Report B / area concerned - remarks:

On the basis of the deformations of the reactor and of the damages to the building, Cheminova Agro estimated that the pressure in the reactor reached values of 25˜35 bar and that the overpressure in the building reached values of 100˜150 mbar. In the Original Report there is no evidence on significant effects outside the process building.

Appendix Full Report B / people:

6 people inside the establishment were injured by the explosion and they were hospitalized but for observation only. The internal fire brigade (20 people) extinguished the fire assisted by the local fire brigade (12 people). A physician from Thyboroen provided first aid to the 6 operators who were exposed to the explosion.

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 process building, the control room, the process and control equipment were heavily during the accident. The cost of the damages has been evaluated in about 15 millions DKR (about 1.9 MECU).

Appendix Full Report B / disruption of community life:

In the Original Report there is no evidence of significant effects outside the process building.

Appendix Full Report C / lesson learned - prevent:

After this accident, the following measures were established:

1- the emergency shut-down system to be indipendent from the unit (operation) control system;

2- redundancy in the control system to be provided;

3- process supervision (warning/alarm) signals to be improved;

4- temperature and chlorine addition rate control systems to be improved;

5- safety management system to be improved;

6- man-machine communication system to be improved.

Appendix Full Report C / lesson learned - mitigate:

The buildings, the process and control equipment will be rebuilt and modified.

After this accident, it was established that the control room structure should be strengthened and direct access from the production hall to it had to be eliminated.

>