

Kraftig explosion som resulterade i brand i en anläggning för etylenoxidproduktion på ett raffinaderi.

870703 MARS 1800_004_004

Vid igångkörning av en destillationskolonn i en anläggning för etylenoxidproduktion inträffade en explosion i destillationskolonnen. Explosionen utlöstes av en kraftig värmeutvecklande nedbrytningsreaktion av etylenoxiden. I explosionsögonblicket befann sig samtliga anställda av en händelse i kontrollrummet. Den enda varningssignal som gavs kom blott ett par sekunder före explosionen. De interna telekommunikations- och larmsystemen förstördes. Manskaper stängde av den övriga fabriken från kontrollrummet och bekämpade branden, och extern hjälp tillkallades. Denna var på plats efter 10 minuter. Branden släcktes inom en halvtimme.

Styren frigjordes från en tank i en av de närliggande fabrikerna då tanken skadades av splitter.

Den direkta orsaken ansågs vara antingen att etylenoxiden reagerat med isoleringsmaterialet vid flänsen i en tätning, eller mindre sannolikt att etylenoxiden reagerat med rostpartiklar. Inget stöd fanns för den senare uppfattningen. Detta tillskrevs bristfälliga rutiner, och bristfällig anläggningskonstruktion.

Inblandade ämnen och mängder

	CAS Nr.	Mängd
Etylenoxid	75-21-8	Okänt
Styren	100-42-5	Okänt

Skador:

Människor:	13 operatörer vid anläggningen och en operatör vid en angränsande fabrik skadades lindrigt. Den allvarligaste skadan var en bruten arm.
Materiella:	Kraftiga materiella skador på anläggningen: destillationskolonnen totalförstördes - bitar av den upptäcktes 700 m bort, några av dem i en angränsande fabrik. Närliggande fabriker skadades också. De flesta byggnader i en radie av 300 m skadades. Utanför fabriksområdet krossades fönster i såväl de angränsande fabrikerna som i den närliggande byn Zwijndrecht 1 km bort.
Miljö/ekologi:	Inga skador rapporterade.
Infrastruktur:	Katastrofplanen för Antwerpens hamnområde aktiverades till följd av explosionen.

Erfarenheter redovisade (Ja/Nej): Ja

Rapporten listar ett antal konkreta åtgärder på fabriken för att undvika framtida explosioner av detta slag, men även åtgärder för att förbättra katastrofberedskapen.

Report Profile

Identification of Report:

country: FA ident key: 1800_004_04

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

Date of Major Occurrence: Time of Major Occurrence

start: 03/07/1987 start: 19:08:00

finish: 03/07/1987 finish:

Establishment:

name:

address:

industry: 2002 petrochemical, refining, processing

Petrochemical (Ethylene Oxide Production)

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_004_04

Accident Types:

release: Yes **explosion:** Yes

water contamination: No **other:** No

fire: Yes

description:

ACCIDENT CASE HISTORY DESCRIPTION:... see Appendix Short Report / description of accident types

Substance(s) Directly Involved:

toxic: Yes **explosive:** Yes

ecotoxic: No **other:** No

flammable: Yes

description:

- Ethylene Oxide (C.A.S. CODE: 75-21-8): amount involved = not known.... see Appendix Short Report / description of substances involved

Immediate Sources of Accident:

storage: No **transfer:** No

process: Yes **other:** No

description:

The accident occurred during the start-up of the redistillation column of the ethylene oxide plant which came into operation in 1969 in a petrochemical industry. This plant had been shut-down in June from 1 to 23. When it was started up pro... see Appendix Short Report / description of immediate sources

Suspected Causes:

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

human: No **other:** No

description:

CAUSES:... 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: 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:

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

A Occurrence Full Report

country: FA **ident key:** 1800_004_04

1 Type of Accident

remarks: During the start-up of the ethylene oxide plant, a vapour cloud

explosion (code 1307) occurred caused by the decomposition of ethylene oxide, released from a flange (code 1101), in the base section of the redistillation column. The explosi... see Appendix Full Report A / type of accident

2 Dangerous Substances

remarks: No data are available about the amount of ethylene oxide and styrene

involved in the accident. Styrene was released from a tank of a nearby plant damaged by the explosion in the redistillation column.

3 Source of Accident

illustration: - not applicable -

remarks: The accident occurred during the start-up of the redistillation column (code 4007) in the ethylene oxide plant (code 3201) which came into operation in 1969 in a petrochemical industry (code 2002). This plant had been shut-down in June from... 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 applicable -

5 Causes of Major Occurrence

main causes

technical / physical 5102 operation: component/machinery failure/malfunction

5107 operation: unexpected reaction/phase-transition

- not applicable -

- not applicable -

- not applicable -

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

5307 organization: process analysis (inadequate, incorrect)

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

- not applicable -

- not applicable -

remarks: The accident was caused by the decomposition of ethylene oxide (code 5107). The ethylene oxide was released from a flange (code 5102) that had been insulated during shut-down. During the start-up, the released EO reacted exothermically with... see Appendix Full Report A / causes of major occurrence

6 Discussion about the Occurrence

- not applicable -

Type of Accident country: FA ident key: 1800_004_04

event:

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

initiating event - not applicable -

associated event - not applicable -

event:

major occurrence 1202 fire: pool fire (burning pool of liquid, contained or uncontained)

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

associated event - not applicable -

Dangerous substances

country: FA **ident key:** 1800_004_04

a) total establishment inventory

CAS number: 100-42-5 **identity:** Styrene

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: 75-21-8 **identity:** Ethylene Oxide

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

Source of Accident - Situation country: FA **ident key:** 1800_004_04

situation

industry

initiating event 2002 petrochemical, refining, processing

associated event - not applicable -

activity/unit

major occurrence 3102 process: chemical continuous reaction

initiating event 3102 process: chemical continuous reaction

associated event - not applicable -

component

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

initiating event 4007 machinery/equipment (pump, filter, column separator, mixer, etc.)

associated event - not applicable -

B Consequences Full Report

country: FA **ident key:** 1800_004_04

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 There were considerable damages inside the establishment: the redistillation col... see Appendix Full Report B / area concerned - remarks

2 People

establishment popul. emergency personnel off-site population

total at risk -1 -1 -1

immediate fatalities 0 0 0

subsequent fatalities 0 0 0

hospitalizing injuries 14 0 0

other serious injuries 0 0 0

health monitoring 0 0 0

remarks 13 operators (two of them were of an external factory working for BP Chemicals) ... 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 BFr ECU BFr

material losses -1 -1 -1 -1

response, clean up, restoration -1 -1 -1 -1

remarks There were considerable damages inside the establishment: the redistillation col... 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, window panes were broken in neighbouring factories an...
see Appendix

7 Discussion of Consequences

Ecological Components involved

country: FA **ident key:** 1800_004_04

type: - not applicable -

threatened: not applicable **affected:** not applicable

C Response Full Report

country: FA **ident key:** 1800_004_04

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, the follow... see Appendix Full Report C / lesson learned - mitigate

useful references:

not given

5 Discussion about Response

- not applicable -

Appendices for the FA / 1800_004_04 report

Appendix Short Report / description of accident types:

ACCIDENT CASE HISTORY DESCRIPTION:

During the start-up, an explosion occurred in the redistillation column of the ethylene oxide plant which came into operation in 1969 in a petrochemical industry. This plant had been shut-down in June from 1 to 23. When it was started up problems were experienced in stabilizing the column and a number of repairs were made to the pumps and instrumentation. On the day of the explosion, the column was sufficiently stable. When the explosion occurred all the employees were by chance in the control room. No alarm signals sounded during the last 30 minutes before the explosion occurred except the general alarm that sounded a few seconds before. Despite of the difficult internal communication caused by the destruction of the internal telephone and alarm systems and the emergency control centre, the operators started to shut-down the other plants of the factory and to fight the fire. The external emergency services and the authorities were informed on the accident and the emergency plan for the Antwerp harbour was activated. The emergency services arrived on site in 10 minutes and with the help of the factory's operators put out the fire and the release of chemicals within half an hour. 13 operators (two of them were of an external factory working for BP Chemicals) and a person outside the establishment (working in a neighbouring factory) were slightly hurt. The most serious injury was a broken arm. There were considerable damages inside the establishment: the redistillation column (32 metres high and 2.3 metres in diameter) was completely destroyed and pieces were found up to 700 metres away, some in a neighbouring factory. The ethylene oxide plant and other nearby plants were seriously damaged. Most of the buildings in a radius of 300 metres were damaged. The internal alarm and telephone systems were damaged and could not be used. The emergency control room was also unusable. Outside the establishment, window panes were broken in neighbouring factories and the nearby village of Zwijndrecht (about 1 Km away). Nobody was hurt in the village.

Appendix Short Report / description of substances involved:

- Ethylene Oxide (C.A.S. CODE: 75-21-8): amount involved = not known.

- Styrene (C.A.S. CODE: 100-42-5, E.E.C. CODE: 601-026--00-0): amount involved = not known (styrene was released from a tank of a nearby plant damaged by the explosion in the redistillation column).

Appendix Short Report / description of immediate sources:

The accident occurred during the start-up of the redistillation column of the ethylene oxide plant which came into operation in 1969 in a petrochemical industry. This plant had been shut-down in June from 1 to 23. When it was started up problems were experienced in stabilizing the column and a number of repairs were made to the pumps and instrumentation. On the day of the explosion, the column was sufficiently stable.

Appendix Short Report / description of suspected causes:

CAUSES:

The accident was caused by the decomposition of ethylene oxide at the base section of the redistillation column. There are two possible causes for this accident:

- 1- a leak of ethylene oxide from a flange that had been insulated during shut-down. During the start-up, the released ethylene oxide reacted exothermically with the binders of the lagging and this caused a temperature increase that ignited the ethylene oxide;
2. the development of a hot spot in a quiescent area of the column caused by the polymerization of ethylene oxide catalysed by rust deposits (this is less likely because no conclusive evidence of it was found).

Appendix Short Report / description of immediate effects:

EFFECTS ON PEOPLE:

13 operators (two of them were of an external factory working for BP Chemicals) and a person outside the establishment (working in a neighbouring factory) were slightly hurt. The most serious injury was a broken arm. Nobody was hurt in the nearby village of Zwijndrecht.

MATERIAL LOSS:

There were considerable damages inside the establishment: the redistillation column (32 metres high and 2.3 metres in diameter) was completely destroyed and pieces were found up to 700 metres away, some in a neighbouring factory. The ethylene oxide plant and other nearby plants were seriously damaged. Most of the buildings in a radius of 300 metres were damaged. The internal alarm and telephone systems were damaged and could not be used. The emergency control room was also unusable. Outside the establishment, window panes were broken in neighbouring factories and the nearby village of Zwijndrecht (about 1 Km away).

COMMUNITY DISRUPTION:

Outside the establishment, window panes were broken in neighbouring factories and the nearby village of Zwijndrecht (about 1 Km away).

Appendix Short Report / description of emergency measures taken:

INTERNAL TO THE ESTABLISHMENT:

No alarm signals sounded during the last 30 minutes before the explosion occurred except the general alarm that sounded a few seconds before. Despite of the difficult internal communication caused by the destruction of the internal telephone and alarm systems and the emergency control centre, the operators started to shut-down the other plants of the factory and to fight the fire. The external emergency services and the authorities were informed on the accident. The emergency services arrived on site in 10 minutes and with the help of the factory's operators put out the fire and the release of chemicals within half an hour.

EXTERNAL TO THE ESTABLISHMENT:

The external emergency services and the authorities were informed on the accident and the emergency plan for the Antwerp harbour was activated.

Appendix Short Report / description of immediate lessons learned:

MEASURES TO PREVENT ANY RECURRENCE OF SIMILAR ACCIDENTS:

After the accident, the following measures were established:

- 1- flanges must not be insulated. If insulation was necessary, the insulation material had to be checked on a possible reaction with ethylene oxide. Use of proper gaskets for flanges;
- 2- all pipeworks and pieces of equipment that may contain rust must be cleaned and inspected before restarting the installation.

MEASURES TO MITIGATE THE EFFECTS OF THE ACCIDENT:

After the accident, the following measures were established:

- 1- improvement of both communication and alarm systems;
- 2- installation of a second control room to be used in emergency situations;

- 3- modifications of the access system;
- 4- revision of the internal emergency plan including a better method of identifying people on-site;
- 5- additional access road to the establishment;
- 6- improvement of the existing supply for fire fighting water.

Appendix Full Report A / type of accident:

During the start-up of the ethylene oxide plant, a vapour cloud explosion (code 1307) occurred caused by the decomposition of ethylene oxide, released from a flange (code 1101), in the base section of the redistillation column. The explosion was followed by a fire (code 1202).

Appendix Full Report A / source of accident - remarks:

The accident occurred during the start-up of the redistillation column (code 4007) in the ethylene oxide plant (code 3201) which came into operation in 1969 in a petrochemical industry (code 2002). This plant had been shut-down in June from 1 to 23. When it was started up problems were experienced in stabilizing the column and a number of repairs were made to the pumps and instrumentation. On the day of the explosion, the column was sufficiently stable.

Appendix Full Report A / causes of major occurrence:

The accident was caused by the decomposition of ethylene oxide (code 5107). The ethylene oxide was released from a flange (code 5102) that had been insulated during shut-down. During the start-up, the released EO reacted exothermically with the binders of the lagging causing a temperature increase that ignited the EO in column. The underlying causes were insufficient procedures (testing and inspection) together with inadequate process analysis and plant design (codes 5303, 5307 and 5308).

Appendix Full Report B / area concerned - remarks:

There were considerable damages inside the establishment: the redistillation column (32 metres high and 2.3 metres in diameter) was completely destroyed and pieces were found up to 700 metres away, some in a neighbouring factory. The ethylene oxide plant and other nearby plants were seriously damaged. Most of the buildings in a radius of 300 metres were damaged. Outside the establishment, window panes were broken in neighbouring factories and the nearby village of Zwijndrecht (about 1 Km away).

Appendix Full Report B / people:

13 operators (two of them were of an external factory working for BP Chemicals) and a person outside the establishment (working in a neighbouring factory) were slightly hurt. The most serious injury was a broken arm. Nobody was hurt in the nearby village of Zwijndrecht.

Appendix Full Report B / ecological harm:

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

Appendix Full Report B / material loss:

There were considerable damages inside the establishment: the redistillation column was completely destroyed and pieces were found up to 700 metres away, some in a neighbouring factory. The ethylene oxide plant and other nearby plants were seriously damaged. Most of the buildings in a radius of 300 metres were damaged. Outside the establishment, window panes were broken in neighbouring factories and the nearby village of Zwijndrecht (about 1 Km away).

Appendix Full Report B / disruption of community life:

Outside the establishment, window panes were broken in neighbouring factories and the nearby village of Zwijndrecht (about 1 Km away). Nobody was hurt in the nearby village of Zwijndrecht. The emergency plan for the Antwerp harbour was activated.

Appendix Full Report C / lesson learned - prevent:

After the accident, the following measures were established:

- 1- flanges must not be insulated. If insulation was necessary, the insulation material had to be checked on a possible reaction with ethylene oxide. Use of proper gaskets for flanges;
- 2- all pipeworks and pieces of equipment that may contain rust must be cleaned and inspected before restarting the installation.

Appendix Full Report C / lesson learned - mitigate:

After the accident, the following measures were established:

- 1- improvement of both communication and alarm systems;
- 2- installation of a second control room to be used in emergency situations;

- 3- modifications of the access system;
- 4- revision of the internal emergency plan including a better method of identifying people on-site;
- 5- additional access road to the establishment;
- 6- improvement of the existing supply for fire fighting water.