

# Explosion och brand till följd av en skenande reaktion på en fabrik för produktion av konsthartharts.

920708 MARS 1992\_14

Olyckan inträffade i en reaktor där dicyklopentadien (DCPD) polymeriserades. En mindre operatör blandade i 50% mer DCPD än vad receptet krävde, dvs 30 ton istället för den föreskrivna mängden om 20 ton. Den höga halten DCPD resulterade i kraftig värmeutveckling och en reaktion som inte kunde kontrolleras. Reaktorn exploderade och den brinnande reaktionsblandningen spreds över området. Företagets interna brandkår ryckte ut och kylde anläggningen. Brandkåren från grannföretag hjälpte till. Räddningstjänsten tog över befälet över släckningsarbetet. Polis och ambulans kallades till platsen. Efter att branden var släckt fann man tunga utrustningsdetaljer upp till 1 km bort.

## Inblandade ämnen och mängder

	CAS Nr.	Mängd
dicyklopentadien	77-73-6	30 000 kg
omättade C9-kolväten		6 ton
mättade C9-kolväten		4 ton

## Skador:

Människor:	3 personer omkom och 11 personer skadades. De skadade fördes till sjukhus.
Materiella:	All utrustning inom ett område på 100 gånger 100 meter totalförstördes. Tung utrustningsdetaljer hittades upp till 1 km bort.
Miljö/ekologi:	Släckningsvattnet kontaminerades och behandlades av ett specialistföretag. Viss utsläpp av asbest från brinnande byggnader. Inga effekter rapporterade.
Infrastruktur:	Inga.

## Erfarenheter redovisade (Ja/Nej): Ja

Kortfattat anges förebyggande åtgärder.

## Report Profile

### Identification of Report:

country: FA ident key: 1992\_014\_01

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

### Date of Major Occurrence: Time of Major Occurrence

start: 1992-07-08 start: 09:55:00

finish: 1992-07-08 finish: 23:59:00

### Establishment:

name:

address:

industry: 2001 general chemicals manufacture

Organic Chemical (Synthetic Resins 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: 1992\_014\_01

### **Accident Types:**

release: No explosion: Yes

water contamination: Yes other: No

fire: Yes

description:

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

### **Substance(s) Directly Involved:**

toxic: No explosive: Yes

ecotoxic: No other: No

flammable: Yes

description:

- Dicyclopentadiene [DCPD] (C.A.S. CODE: 77-73-6): amount involved = about 30,000 Kg (the reaction vessel was loaded with 30 tonnes of DCPD instead of the required 20 tonnes)... see Appendix Short Report / description of substances involved

### **Immediate Sources of Accident:**

storage: No transfer: No

process: Yes other: No

description:

Because of a mistake in a recipe the reactionvessel was filled with a mixture of monomers containing ca 75% DCPD instead of a mixture with ca 50% DCPD. The meaning of the process is making synthetic resins by heat polymerisation. The too h... see Appendix Short Report / description of immediate sources

### **Suspected Causes:**

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

**human:** Yes **other:** No

**description:**

Due to a mistake (caused by an inadequate training/instruction of the operator) during the filling of a polymerization reactor, the vessel was loaded with about 40 tonnes of a mixture of monomers containing about 75% of DCPD (about 30 tonne... see Appendix Short Report / description of suspected causes

**Immediate Effects:**

**material loss:** Yes

**human deaths:** Yes

**human injuries:** Yes **community disruption:** No

**other:** No

**ecological harm:** Yes

**national heritage loss:** No

**description:**

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

**Emergency Measures taken:**

**on-site systems:** Yes **decontamination:** Yes

**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:** No

**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:** 1992\_014\_01

### 1 Type of Accident

**remarks:** During the polymerization by heat of dicyclopentadiene (DCPD), the reaction vessel was loaded with about 40 tonnes of a mixture of monomers containing about 75% of DCPD (about 30 tonnes) instead of the required 50% (20 tonnes).

The high con... see Appendix Full Report A / type of accident

### 2 Dangerous Substances

**remarks:** During the polymerization by heat of dicyclopentadiene (DCPD), the reaction vessel was loaded with about 40 tonnes of a mixture of monomers containing

about 75% of DCPD (about 30 tonnes) instead of the required 50% (20 tonnes).

The total es... see Appendix Full Report A / dangerous substances

### 3 Source of Accident

**illustration:** - not applicable -

**remarks:** The accident occurred during the polymerization of dicyclopentadiene in a reaction vessel (code 4002) in an organic chemical industry for the synthetic resins production (code 2001). The polymerization of DCPD was carried out in a batch rea... 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** 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:** Due to a mistake (code 5401), caused by an inadequate training/instruction of the operator and by inadequate operating instructions (codes 5303 and 5304), a reactor was loaded with about 40 tonnes of a mixture of monomers containing about 7... see Appendix Full Report A / causes of major occurrence

### 6 Discussion about the Occurrence

- not applicable -

**Type of Accident** country: FA ident key: 1992\_014\_01

**event:**

**major occurrence** 1304 explosion: runaway reaction explosion (usually exothermic)

**initiating event** - not applicable -

**associated event** - not applicable -

**event:**

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

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

**associated event** - not applicable -

## **Dangerous substances**

**country:** FA **ident key:** 1992\_014\_01

### **a) total establishment inventory**

**CAS number: identity:** Unsaturated Resins C9

**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):** 6

**use of substance as:** STARTING MATERIAL

**b) substance belongs to relevant inventory directly involved:** Yes

**actual quantity:** 6 **potential quantity:** 6

**c) substance belongs to relevant inventory indirectly involved:** No

**actual quantity:** -1 **indir\_pot\_quant:** -1

### **a) total establishment inventory**

**CAS number: identity:** Saturated Resins C9

**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):** 4

**use of substance as:** STARTING MATERIAL

**b) substance belongs to relevant inventory directly involved:** Yes

**actual quantity:** 4 **potential quantity:** 4

**c) substance belongs to relevant inventory indirectly involved:** No

**actual quantity:** -1 **indir\_pot\_quant:** -1

### **a) total establishment inventory**

**CAS number:** 77-73-6 **identity:** Dicyclopentadiene

**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):** 30

**use of substance as:** STARTING MATERIAL

**b) substance belongs to relevant inventory directly involved:** Yes

**actual quantity:** 30 **potential quantity:** 30

**c) substance belongs to relevant inventory indirectly involved:** No

**actual quantity:** -1 **indir\_pot\_quant:** -1

**Source of Accident - Situation** country: FA ident key: 1992\_014\_01

## **situation**

**industry**

**initiating event** 2001 general chemicals manufacture

**associated event** - not applicable -

**activity/unit**

**major occurrence** 3101 process: chemical batch reaction

**initiating event** 3101 process: chemical batch reaction

**associated event** - not applicable -

**component**

**major occurrence** 4002 reaction vessel; pressurised

**initiating event** 4002 reaction vessel; pressurised

**associated event** - not applicable -

## **B Consequences Full Report**

country: FA ident key: 1992\_014\_01

### **1 Area concerned**

**affected**

**extent of effects installation:** Yes

**establishment:** Yes

**off-site; local:** Yes

**off-site; regional:** No

**off-site; transboundary:** not applicable

**illustration of effects** - not applicable -

**remarks** All the equipment in an area of about 100x100 m2 were destroyed. No injuries occ... see Appendix

Full Report B / area concerned - remarks

### **2 People**

**establishment popul. emergency personnel off-site population**

**total at risk** 62

**immediate fatalities** 3

**subsequent fatalities**

**hospitalizing injuries** 11

**other serious injuries**

**health monitoring**

**remarks** Inside the plant, 3 people died and 11 were injured (and hospitalized). No inju... see Appendix

Full Report B / people

### **3 Ecological Harm**

**pollution/contamination/damage of:**

- **residential area (covered by toxic cloud)** not applicable
- **common wild flora/fauna (death or elimination)** not applicable
- **rare or protected flora/fauna (death or elimination)** not applicable
- **water catchment areas and supplies for consumption or recreation** not applicable
- **land (with known potential for long term ecological harm or not applicable**

**preventing human access or activities)**

- **marine or fresh water habitat** not applicable
- **areas of high conservation value or given special protection** not applicable

**remarks** The water used for fire fighting caused a water pollution but form the Original ... 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** All the equipment in an area of about 100x100 m2 were destroyed and heavy parts ... 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 No injuries occurred outside the plant but heavy parts of the installation were ... see Appendix

**7 Discussion of Consequences**

# C Response Full Report

country: FA ident key: 1992\_014\_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:

- not applicable -

useful references:

- not applicable -

### 5 Discussion about Response

- not applicable -

## Appendices for the FA / 1992\_014\_01 report

### Appendix Short Report / description of accident types:

ACCIDENT CASE HISTORY DESCRIPTION:

During the polymerization of dicyclopentadiene (DCPD), the reaction vessel was loaded with about 40 tonnes of a mixture of monomers containing about 75% of DCPD (about 30 tonnes) instead of the required 50% (20 tonnes). The high concentration of DCPD caused a runaway reaction that burst the reaction vessel (a safety valve was provided but with a wrong [too low] capacity) and resulted in an explosion followed by a huge fire. Inside the plant, 3 people died and 11 were injured (and hospitalized). No injuries occurred outside the plant. All the equipment in an area of about 100x100 m<sup>2</sup> were destroyed. Heavy parts of the installation were found in a range of 1 Km from the plant. The water used for fire fighting caused a water pollution.

### Appendix Short Report / description of substances involved:

- Dicyclopentadiene [DCPD] (C.A.S. CODE: 77-73-6): amount involved = about 30,000 Kg (the reaction vessel was loaded with 30 tonnes of DCPD instead of the required 20 tonnes).

- Resins as Unsaturated Hydrocarbons C9: amount involved = about 6 tonnes.

- Resins as Saturated Hydrocarbons C9: amount involved = about 4 tonnes.

### Appendix Short Report / description of immediate sources:

Because of a mistake in a recipe the reaction vessel was filled with a mixture of monomers containing ca 75% DCPD instead of a mixture with ca 50% DCPD. The meaning of the process is making synthetic resins by heat polymerisation. The too high content ratio of DCPD led to a runaway reaction.

### **Appendix Short Report / description of suspected causes:**

Due to a mistake (caused by an inadequate training/instruction of the operator) during the filling of a polymerization reactor, the vessel was loaded with about 40 tonnes of a mixture of monomers containing about 75% of DCPD (about 30 tonnes) instead of the required 50% (20 tonnes). The high concentration of DCPD caused a runaway reaction that burst the reaction vessel (a safety valve was provided but with a wrong [too low] capacity) and resulted in an explosion followed by a huge fire.

- an error in the recipe
- a failing check on the recipe
- an insufficient equipment to control the reaction when runaway behaviour occurs. Even a big safety valve is not enough.
- an insufficient knowledge about the reaction behaviour of DCPD containing mixtures
- investigation has shown that there were deficiencies in the company safety procedures.

### **Appendix Short Report / description of immediate effects:**

#### EFFECTS ON PEOPLE:

Inside the plant, 3 people died and 11 were injured (and hospitalized). No injuries occurred outside the plant.

#### MATERIAL LOSS:

All the equipment in an area of about 100x100 m<sup>2</sup> were destroyed. Heavy parts of the installation were found in a range of 1 Km from the plant. No data are available about the cost of these damages.

#### ECOLOGICAL HARM:

Release of asbestos fibres from building materials. Soil pollution by solvents and polluted water of the fire fighting.

### **Appendix Short Report / description of emergency measures taken:**

#### INTERNAL TO THE ESTABLISHMENT:

The company fire brigade (about 12 people) was activated and cooled the installation.

#### EXTERNAL SERVICES:

The fire fighting operations were carried out by the fire brigade of Uithoorn assisted by the fire brigades of other sites (about 50 people). The command and control was assumed by the Regional fire brigade. Police and ambulance services were activated.

#### DECONTAMINATION:

The water used for fire fighting caused a water pollution. Decontamination was carried out by a specialized firm and about 40 people were involved.

### **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- improvement of the training/instruction of the personnel;
- 2- better knowledge of the chemistry of the reaction;
- 3- improvement of the operating procedures (particularly with reference to the reactor's filling and the checks to be carry out on the recipe);
- 4- re-design the sizing of vents and safety valves.

### **Appendix Full Report A / type of accident:**

During the polymerization by heat of dicyclopentadiene (DCPD), the reaction vessel was loaded with about 40 tonnes of a mixture of monomers containing about 75% of DCPD (about 30 tonnes) instead of the required 50% (20 tonnes). The high concentration of DCPD caused a runaway reaction that burst the reaction vessel (a safety valve was provided but with a wrong [too low] capacity) and resulted in an explosion (code 1304) followed by a huge fire (code 1202).

### **Appendix Full Report A / dangerous substances:**

During the polymerization by heat of dicyclopentadiene (DCPD), the reaction vessel was loaded with about 40 tonnes of a mixture of monomers containing about 75% of DCPD (about 30 tonnes) instead of the required 50% (20 tonnes). The total establishment and the potential directly involved inventories of DCPD and of resins refer to the amounts loaded in the polymerization reactor.

### **Appendix Full Report A / source of accident - remarks:**

The accident occurred during the polymerization of dicyclopentadiene in a reaction vessel (code 4002) in an organic chemical industry for the synthetic resins production (code 2001). The polymerization of DCPD was carried out in a batch reactor (code 3101). From the Original Report is not fully clear if the polymerization was carried out in pressurized reactors or not.

### **Appendix Full Report A / causes of major occurrence:**

Due to a mistake (code 5401), caused by an inadequate training/instruction of the operator and by inadequate operating instructions (codes 5303 and 5304), a reactor was loaded with about 40 tonnes of a mixture of monomers containing about 75% of DCPD (about 30 tonnes) instead of the required 50% (20 tonnes). The high concentration of DCPD caused a runaway reaction (code 5106) that burst the reaction vessel (a safety valve was provided but with a wrong [too low] capacity, codes 5307 and 5308).

### **Appendix Full Report B / area concerned - remarks:**

All the equipment in an area of about 100x100 m<sup>2</sup> were destroyed. No injuries occurred outside the plant but heavy parts of the installation were found in a range of 1 Km from the plant. The water used for fire fighting caused a water pollution. Decontamination was carried out by a specialized firm and about 40 people were involved.

### **Appendix Full Report B / people:**

Inside the plant, 3 people died and 11 were injured (and hospitalized). No injuries occurred outside the plant. The company fire brigade (12 people) was assisted by the fire brigade of Uithoorn and of other sites (about 50 people).

### **Appendix Full Report B / ecological harm:**

The water used for fire fighting caused a water pollution but from the Original Report it is not fully clear what type of pollution it was.

### **Appendix Full Report B / material loss:**

All the equipment in an area of about 100x100 m<sup>2</sup> were destroyed and heavy parts of the installation were found in a range of 1 Km from the plant. No data are available about the cost of the material losses.

### **Appendix Full Report B / disruption of community life:**

No injuries occurred outside the plant but heavy parts of the installation were found in a range of 1 Km from the plant. The water used for fire fighting caused a water pollution.

### **Appendix Full Report C / lesson learned - prevent:**

After the accident, the following measures were established:

- 1- improvement of the training/instruction of the personnel;
- 2- better knowledge of the chemistry of the reaction;
- 3- improvement of the operating procedures (particularly with reference to the reactor's filling and the checks to be carry out on the recipe);
- 4- re-design the sizing of vents and safety valves.