

Explosion på en kemikaliefabrik.

880227 MARS 1988_23

Vi destillation av orto-nitrobenzaldehyd skenade en oväntad kraftigt värmeutvecklande sidoreaktion vilket ledde till att destillationskärlet splittrades i en explosion. Man avsåg att redestillera orto-nitrobenzaldehyd från ett råmaterial som framställdes 6 månader tidigare. Under lagertiden hade ansenliga mängder termiskt instabil orto-nitrobenzylnitrat bildats. Innan destillation hade man testkört råprodukten på laboratorium utan problem, men när huvudmängden skulle destilleras behandlades den inte på samma sätt. orto-nitrobenzylnitratet bröts ned i en kraftigt värmeutvecklande sidoreaktion. Företagets interna brandkår kunde släcka branden utan hjälp från räddningstjänsten.

Inblandade ämnen och mängder

	CAS Nr.	Mängd
orto-nitrobenzaldehyd	552-89-6	300 kg

Skador:

Människor:	Två av de fyra människor som befann sig i närheten av explosionen fick föras till sjukhuset.
Materiella:	Byggnaden totalförstördes och fönster och tak på byggnader upp till 400 m bort skadades.
Miljö/ekologi:	Inga effekter rapporterade.
Infrastruktur:	Inga.

Erfarenheter redovisade (Ja/Nej): Ja

Mycket kortfattat anges förebyggande åtgärder.

Report Profile

Identification of Report:

country: FA ident key: 1988_023_01

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

Date of Major Occurrence: Time of Major Occurrence

start: 1988-02-27 start: 20:00:00

finish: finish:

Establishment:

name:

address:

industry: 2001 general chemicals manufacture

Organic Chemical (Batch Processing for a Wide Range of Chemicals)

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:** 1988_023_01

Accident Types:

release: No **explosion:** Yes

water contamination: No **other:** No

fire: No

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:

- Ortho-nitrobenzaldehyde (C.A.S. CODE: 552-89-6): amount involved = 300 kg.... see Appendix Short Report /

description of substances involved

Immediate Sources of Accident:

storage: No **transfer:** No

process: Yes **other:** No

description:

The accident occurred in a vessel used for the distillation of o-nitrobenzaldehyde. The process plant was part of an organic chemical industry manufacturing a wide range of chemicals. The component involved was a stainless steel insulated v... 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:** 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:** 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:** 1988_023_01

1 Type of Accident

remarks: The violent runaway decomposition of o-nitrobenzyl nitrate during the distillation of crude o-nitrobenzaldehyde caused the burst of the stainless steel vessel used for distillation processes (code 1304). The runaway explosion had a deflagrat... see Appendix Full Report A / type of accident

2 Dangerous Substances

remarks: The explosion was caused by the violent runaway decomposition of o-nitrobenzyl nitrate formed by the oxidation of the crude material (o-nitrobenzaldehyde) occurred during its storage (6 months long). No data are available about the amount of... see Appendix Full Report A / dangerous substances

3 Source of Accident

illustration: - not applicable -

remarks: The accident occurred in a 1,250 litres capacity stainless steel vessel

(code 4007) used for the distillation (code 3104) of o-nitrobenzaldehyde in an organic chemical industry (code 2001) were batch processes of a wide range of chemicals w... 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 5307 organization: process analysis (inadequate, incorrect)

5401 person: operator error

- not applicable -

- not applicable -

- not applicable -

remarks: The vessel explosion was caused by an exothermic runaway reaction accelerated to a deflagration (code 5106). The runaway reaction occurred due to the formation of appreciable amounts of the thermally unstable o-nitrobenzyl nitrate during the... see Appendix Full Report A / causes of major occurrence

6 Discussion about the Occurrence

- not applicable -

Type of Accident country: FA ident key: 1988_023_01

event:

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

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

associated event - not applicable -

Dangerous substances

country: FA ident key: 1988_023_01

a) total establishment inventory

CAS number: identity: O-nitrobenzyl nitrate

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: 552-89-6 **identity:** O-nitrobenzaldehyde

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): 0,3

use of substance as: STARTING MATERIAL

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 0,3 **potential quantity:** 0,3

c) substance belongs to relevant inventory indirectly involved: No

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

Source of Accident - Situation country: FA **ident key:** 1988_023_01

situation

industry

initiating event 2001 general chemicals manufacture

associated event - not applicable -

activity/unit

major occurrence 3104 process: physical operations (mixing, melting crystallizing, etc.)

initiating event 3104 process: physical operations (mixing, melting crystallizing, etc.)

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: 1988_023_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 extent of the effects of the explosion is shown on a map attached to the Ori... see Appendix

Full Report B / area concerned - remarks

2 People

establishment popul. emergency personnel off-site population

total at risk 4

immediate fatalities

subsequent fatalities

hospitalizing injuries 2

other serious injuries

health monitoring

remarks Inside the establishment, 2 people out of 4 present were injured by the explosio... 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 factory was completely destroyed. Up to a distance of about 400 metres from ... 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 The roofs and the windows of the neighbouring premises were damaged by the explo... see Appendix

7 Discussion of Consequences

C Response Full Report

country: FA **ident key:** 1988_023_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:

The effects of the deflagratio... see Appendix Full Report C / lesson learned - references

5 Discussion about Response

- not applicable -

Appendices for the FA / 1988_023_01 report

Appendix Short Report / description of accident types:

ACCIDENT CASE HISTORY DESCRIPTION:

The accident occurred during the distillation of crude ortho-nitrobenzaldehyde. Six months prior to the final processing the material was oxidized with nitric acid and the products set aside. This led to the formation of appreciable amounts of thermally unstable ortho-nitrobenzyl nitrate being formed. This was not recognized and resulted in an earlier exotherm and more vigorous acceleration than had been anticipated. However, immediately prior to distillation, a sample of the crude product was tested using a differential scanning calorimetry method to determine the temperature at which an exothermic reaction would begin. The crude had been washed with water, toluene and caustic prior to testing but the test equipment differed from that specified, and the condensation of water within the equipment masked the identification of an exothermic reaction in the sample. With the information from the test indicating that there was no exotherm likely at and around the operating temperature, the process of distillation of the bulk material was started. At about 140 °C an exothermic reaction occurred rapidly reducing the vacuum in the system to a positive pressure with final violent runaway resulting in deflagration. The vessel (although equipped with a high-temperature alarm [set at 140 °C], a high-temperature trip of the steam supply [set at 150 °C] and a second trip [set at 170 °C] activating the dumping of the heavy hydrocarbons) could not cope with this speed of reaction and did not prevent escalation. It is thought that the automatic dumping system did not operate.

Appendix Short Report / description of substances involved:

- Ortho-nitrobenzaldehyde (C.A.S. CODE: 552-89-6): amount involved = 300 kg.

- Ortho-nitrobenzyl nitrate: amount involved = not known.

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Appendix Short Report / description of immediate sources:

The accident occurred in a vessel used for the distillation of o-nitrobenzaldehyde. The process plant was part of an organic chemical industry manufacturing a wide range of chemicals. The component involved was a stainless steel insulated vessel of 1,250 litres capacity used for a distillation process. The distillation device was equipped with temperature alarm/control, cooling system and automatic dumping system. The location of the plant is shown on a map attached to the Original Report.

Appendix Short Report / description of suspected causes:

INITIATING EVENT AND CONSEQUENCES:

An exothermic reaction accelerated to deflagration shattering the distillation vessel and causing widespread damage to the premises and some damage to the surroundings.

CAUSES

The explosion of the vessel was caused by an exothermic runaway reaction accelerated to a deflagration. The runaway reaction occurred due to the formation of appreciable amounts of the thermally unstable o-nitrobenzyl nitrate during the storage (6 months long) of the crude material (o-nitrobenzaldehyde). The formation of o-nitrobenzyl nitrate was unexpected due to an inadequate process analysis and the risk of a runaway reaction was not recognized because the laboratory analysis on a sample of the crude product were carried out in a wrong way.

Appendix Short Report / description of immediate effects:

EFFECTS ON PEOPLE:

Inside the establishment 2 out of 4 people exposed to the explosion were hospitalized.

MATERIAL LOSS:

Complete destruction of the factory. The windows and the roofs of the neighbouring premises were damaged up to about 400 metres from the plant.

MAP OF THE ACCIDENT AREA:

The extent of the effects of the explosion is shown on a map attached to the Original Report. In that map the estimated over-pressures and the related effects to people and to structures are shown.

Appendix Short Report / description of emergency measures taken:

INTERNAL TO THE ESTABLISHMENT:

Immediate evacuation of the premises and making safe of other hazardous materials.

EXTERNAL SERVICES:

Immediate attendance by emergency services but no assistance external to the establishment was required.

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- no further processing of this substance;
- 2- a review of the management system and control of processes.

Appendix Full Report A / type of accident:

The violent runaway decomposition of o-nitrobenzyl nitrate during the distillation of crude o-nitrobenzaldehyde caused the burst of the stainless steel vessel used for distillation processes (code 1304). The runaway explosion had a deflagrative behaviour.

Appendix Full Report A / dangerous substances:

The explosion was caused by the violent runaway decomposition of o-nitrobenzyl nitrate formed by the oxidation of the crude material (o-nitrobenzaldehyde) occurred during its storage (6 months long). No data are available about the amount of o-nitrobenzyl nitrate formed during the storage. The total establishment and the potential directly involved inventories of o-nitrobenzaldehyde refer to the amount involved in the accident.

Appendix Full Report A / source of accident - remarks:

The accident occurred in a 1,250 litres capacity stainless steel vessel (code 4007) used for the distillation (code 3104) of o-nitrobenzaldehyde in an organic chemical industry (code 2001) where batch processes of a wide range of chemicals were carried out. The location of the factory is shown on a map attached to the Original Report.

Appendix Full Report A / causes of major occurrence:

The vessel explosion was caused by an exothermic runaway reaction accelerated to a deflagration (code 5106). The runaway reaction occurred due to the formation of appreciable amounts of the thermally unstable o-nitrobenzyl nitrate during the storage (6 months long) of the crude material (o-nitrobenzaldehyde). The formation of o-nitrobenzyl nitrate was unexpected due to insufficient process analysis (code 5307) and was not recognized during laboratory analysis due to an operator error (code 5401).

Appendix Full Report B / area concerned - remarks:

The extent of the effects of the explosion is shown on a map attached to the Original Report. In that map the estimated over-pressures and the related damages to people and to structures are shown. The windows and the roofs of the neighbouring premises were damaged up to about 400 metres from the plant.

Appendix Full Report B / people:

Inside the establishment, 2 people out of 4 present were injured by 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 factory was completely destroyed. Up to a distance of about 400 metres from the plant, the windows and the roofs of the neighbouring premises were damaged. No data are available about the cost of the damages.

Appendix Full Report B / disruption of community life:

The roofs and the windows of the neighbouring premises were damaged by the explosion up to about 400 metres from the plant.

Appendix Full Report C / lesson learned - prevent:

After the accident, the following measures were established:

- 1- no further processing of this substance;
- 2- a review of the management system and control of processes.

Appendix Full Report C / lesson learned - references:

The effects of the deflagration of the distillation vessel was equivalent to those of an explosion of about 200 lbs of TNT.