Explosion i en acetylenfabrik

901011 MARS 1800_18

Olyckan inträffade under en påfyllningsmanöver då 100 acetylencylindrar skulle fyllas från en större lagerbehållare.Påfyllningen startade klockan 07:00. Rutinerna fortgick normalt till klockan 09:10 då den första explosionen inträffade. En andra explosion följde inom loppet av 10-15 sekunder. En operatör stängde av strömtillförseln ungefär 45 sekunder efter den första explosionen. Delar av taket blåstes bort och väggen mot elrummet kollapsade delvis. Brand utbröt och ytterligare explosioner inträffade då elva acetylencylindrar sprack (BLEVE). Acetylen släppte också ut från lagerbehållaren. Räddningstjänsten (32 personer) mobiliserades för bekämpning av branden. Anläggingen kyldes med vatten i 24 timmar innan alla ventiler kunde stängas. De cylindrar som utsatts för brand tömdes utomhus. Orsaken till branden var antingen en läckande högtrycksledning, eller en nedbrytning av acetylen som ledde till ett brott på gasledningen.

Inblandade ämnen och mängder

	CAS Nr.	Mängd
acetylen	74-86-2	575 kg
aceton	67-64-1	1025 kg
vätgas	1333-74-0	okänt

Skador:

Människor:	En arbetare chockades och skadades lindrigt av explosionen.
Materiella:	Anläggingen skadades till en uppskattad kostnad om 0,5 MECU. Utanför fabriken krossades några fönster i närbebyggelsen.
Miljö/ekologi:	Inga rapporterade.
Infrastruktur:	Inga.

Erfarenheter redovisade (Ja/Nej): Ja

Kort om förebyggande åtgärder relevanta för fabriken ifråga.

Report Profile

Identification of Report:

country: FA **ident key:** 1800_018_01

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

Date of Major Occurrence: Time of Major Occurrence

start: 11/10/1990 **start:** 09:00:00

finish: finish:

Establishment:

name:

address:

industry: 2002 petrochemical, refining, processing

Gas Processing (Facility for Acetylene Production and Cylinders Filling)

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_018_01

Accident Types:

release: Yes **explosion:** Yes

water contamination: No **other:** No

fire: Yes

description:

An operator switched-off the electric supply system at the main switch about 45 seconds after the first explosion.... see Appendix Short Report / description of accident types

Substance(s) Directly Involved:

toxic: No **explosive:** Yes

ecotoxic: No **other:** No

flammable: Yes

description:

When the accident occurred, in the charging room there were 193 cylinders (16 holding 10 litres, 24 holding 20 litres, 153 holding 40 litres). Each 40 litres cylinder was containing 12.5 Kg of acetone and 7 Kg of acetylene (approximately 3,... see Appendix Short Report / description of substances involved

Immediate Sources of Accident:

storage: No **transfer:** Yes

process: Yes **other:** No

description:

The accident occurred in a gas processing industry for the acetylene production and the cylinders filling, during a filling operation of a charge of 100 cylinders from an acetylene gasholder used to store tha gas produced in the calcium car... 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:** 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:

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_018_01

1 Type of Accident

remarks: The accident occurred during a filling operation of a charge of 100 cylinders from an acetylene gasholder. Due to a leaking high-pressure hose (code 1101) or to a decomposition of acetylene (code 1306) causing pipe rupture, a release of fla... see Appendix Full Report A / type of accident

2 Dangerous Substances

remarks: The total establishment and the potential directly involved inventories of acetylene and acetone refer to the amounts in the charging room. In that room there were 193 cylinders (16 holding 10 l, 24 holding 20 l, 153 holding

40 l) and each ... see Appendix Full Report A / dangerous substances

3 Source of Accident

illustration: - not applicable -

remarks: The accident occurred in a gas processing industry for the acetylene production and cylinders filling (code 2002), during a filling operation (code 3304) of a charge of 100 cylinders (code 4004) from an acetylene gasholder used to store the... 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

5106 operation: runaway reaction

- not applicable -

- not applicable -

- not applicable -

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

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

5313 organization: maintenance/repair (none, inadequate, inappropriate)

- not applicable -

- not applicable -

remarks: The acetylene release into the charging room may have been either a leaking high-pressure hose (code 5102) or a decomposition of acetylene (code 5106) causing a pipe rupture. The underlying causes that led to the leakage from a high-pressur... see Appendix Full Report A / causes of major occurrence

6 Discussion about the Occurrence

- not applicable -

Type of Accident **country:** FA **ident key:** 1800_018_01

event:

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

initiating event 1307 explosion: VCE (vapour cloud explosion; supersonic wave front)

associated event - not applicable -

event:

major occurrence 1302 explosion: BLEVE (boiling liquid expanding vapour explosion)

initiating event 1306 explosion: explosive decomposition (of unstable material)

associated event - not applicable -

event:

major occurrence 1203 fire: jet flame (burning jet of fluid from orifice)

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

associated event - not applicable -

Dangerous substances

country: FA **ident key:** 1800_018_01

a) total establishment inventory

CAS number: identity: Hydrogen

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: 74-86-2 **identity:** Acetylene

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): 1,15

use of substance as: NORMAL FINISHED PRODUCT

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 0,575 **potential quantity:** 1,15

c) substance belongs to relevant inventory indirectly involved: No

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

a) total establishment inventory

CAS number: 67-64-1 **identity:** Acetone

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): 2,05

use of substance as: NORMAL FINISHED PRODUCT

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 1,025 **potential quantity:** 2,05

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_018_01

situation

industry

inititating event 2002 petrochemical, refining, processing

associated event - not applicable -

activity/unit

major occurrence 3304 transfer: loading/unloading activities (transfer interfaces)

inititating event 3304 transfer: loading/unloading activities (transfer interfaces)

associated event - not applicable -

component

major occurrence 4004 container; pressurised (bullet, sphere, cylinder, etc.)

inititating event 4004 container; pressurised (bullet, sphere, cylinder, etc.)

associated event - not applicable -

B Consequences Full Report

country: FA **ident key:** 1800_018_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 In the Original Report there is no evidence of significant effects outside the e... see Appendix

Full Report B / area concerned - remarks

2 People

establishment popul. emergency personnel off-site population

total at risk 2 32

immediate fatalities

subsequent fatalities

hospitalizing injuries 1

other serious injuries

health monitoring

remarks Inside the establishment, one operator was injured (and hosptalized but for obse... 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 3600000

response, clean up, restoration

remarks The explosions and the followinf fires damaged the building, the cylinders filli... 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 In the Original Report there is no evidence of significant effects outside the e... see Appendix

7 Discussion of Consequences

C Response Full Report

country: FA **ident key:** 1800_018_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, it was dec... see Appendix Full Report C / lesson learned - prevent

measures to mitigate consequences:

After the accident, it was dec... see Appendix Full Report C / lesson learned - mitigate

useful references:

- not applicable -

5 Discussion about Response

- not applicable -

Appendices for the FA / 1800_018_01 report

Appendix Short Report / description of accident types:

An operator switched-off the electric supply system at the main switch about 45 seconds after the first explosion.

OTHER SYSTEMS INVOLVED AND OPERATING CONDITIONS:

Low pressure production system including gasholder for acetylene.

The accident occurred during a filling operation of a charge of 100 cylinders from an acetylene gasholder. The filling operation was started in the charging room at 07:00. The filling operation was proceeding smoothly without the operators observing anything unusual (an operator inspected the front of the racks at 09:00 and everything was normal). No particular action by the operators were taken immediately prior to the explosions. The first explosion occurred at 09:10 and the second 10`15 seconds later. Soon after, an operator switched off the electric supply system at the main switch. Part of the roof blew off, windows were blown out and part of the wall between the charging room and the electrical room collapsed. Fires broke out and further explosions occurred. 11 cylinders were either completely ruptured or partially opened. Deflagration or detonation occurred in the piping system and likely in the cylinders. Acetylene was released from the gasholder. This release was either due to continued gas production after the compressors were stopped or acetylene back flow from the high-pressure system where valves were leaking after their seats had melted. The local fire brigade was mobilized (32 firefighters involved) from Holbaek in extinguishing the fire. Cooling by means of water was continued for 24 hours before all the valves could be closed. Cylinders which have been exposed to fire were emptied outdoors.

Appendix Short Report / description of substances involved:

When the accident occurred, in the charging room there were 193 cylinders (16 holding 10 litres, 24 holding 20 litres, 153 holding 40 litres). Each 40 litres cylinder was containing 12.5 Kg of acetone and 7 Kg of acetylene (approximately 3,200 Kg). It has been evaluated that 50% (about 1,600 Kg) of the flammable contents was released from 11 ruptured cylinders and from cylinders which valves were broken off or leaking.

- Acetylene (C.A.S. CODE: 74-86-2, E.E.C. CODE: 601-015-00-0): amount involved = 575 kg;.

- Acetone (C.A.S. CODE: 67-64-1, E.E.C. CODE: 606-001-02-8): amount involved = 1025.

- Hydrogen (C.A.S. CODE: 1333-74-0, E.E.C. CODE: 001-001-00-9): amount involved = not known.

Appendix Short Report / description of immediate sources:

The accident occurred in a gas processing industry for the acetylene production and the cylinders filling, during a filling operation of a charge of 100 cylinders from an acetylene gasholder used to store tha gas produced in the calcium carbide unit . The cylinders charging plant was manually controlled. When the accident occurred the operating conditions were normal.

Appendix Short Report / description of suspected causes:

CAUSES:

The initiating event may have been either a leaking high-pressure hose or a decomposition of acetylene causing pipe rupture and therefore an explosive gas release into the charging room. The underlying causes that led to a leakage from a high-pressure hose were an insufficient component design and an inadequate maintenance program.

Appendix Short Report / description of immediate effects:

EFFECTS ON PEOPLE:

Inside the establishment 1 person was injured (and hospitalized but for observation for shock only) by the explosion.

MATERIAL LOSS:

The explosions and the following fires damaged the building, the cylinders filling equipment and the pressure cylinders. The cost of the damages has been evaluated in about 3.6 millions DKR (about 0.5 MECU).

Outside the establishment a few windows were broken by the explosions but no data are available about their cost.

Appendix Short Report / description of emergency measures taken:

INTERNAL TO THE ESTABLISHMENT:

Cooling by means of water was continued for 24 hours before all the valves could be closed. The charging room was emptied for cylinders. Cylinders which have been exposed to the fire were emptied outdoors.

EXTERNAL SERVICES:

The fire brigade from Holbaek extinguished the fire and cooled the cylinders in the building from outside for 24 hours.

Appendix Short Report / description of immediate lessons learned:

MEASURES TO PREVENT ANY RECURRENCE OF SIMILAR ACCIDENTS:

After the accident, it was decided that in rebuilding the installation and reconstruction of equipment for cylinders filling:

1- the design of piping and piping components should be improved;

2- the maintenance program should be improved.

MEASURES TO MITIGATE THE EFFECTS OF THE ACCIDENT:

After the accident, it was decided that in rebuilding the installation and reconstruction of equipment for cylinders filling:

1- overpressure protection of the acetylene compressors should be improved;

2- a new sprinkler system for the cylinder filling facility will be installed;

3- emergency planning should be improved.

Appendix Full Report A / type of accident:

The accident occurred during a filling operation of a charge of 100 cylinders from an acetylene gasholder. Due to a leaking high-pressure hose (code 1101) or to a decomposition of acetylene (code 1306) causing pipe rupture, a release of flammable gas occurred into the charging room, causing a confined vapour explosion (code 1307). Fires broke out (code 1203) and further explosions occurred, due to BLEVE (code 1302) and runaway reactions (code 1304).

Appendix Full Report A / dangerous substances:

The total establishment and the potential directly involved inventories of acetylene and acetone refer to the amounts in the charging room. In that room there were 193 cylinders (16 holding 10 l, 24 holding 20 l, 153 holding 40 l) and each 40 l cylinder was containing 12.5 Kg of acetone and 7 Kg of acetylene (approximately 3,200 Kg). It has been evaluated that 50% (about 1,600 Kg) of the contents was released from 11 ruptured cylinders and from cylinders which valves were broken off or leaking.

Appendix Full Report A / source of accident - remarks:

The accident occurred in a gas processing industry for the acetylene production and cylinders filling (code 2002), during a filling operation (code 3304) of a charge of 100 cylinders (code 4004) from an acetylene gasholder used to store the gas produced in the calcium carbide unit. The cylinders charging plant was manually controlled. When the accident occurred the operating conditions were normal.

Appendix Full Report A / causes of major occurrence:

The acetylene release into the charging room may have been either a leaking high-pressure hose (code 5102) or a decomposition of acetylene (code 5106) causing a pipe rupture. The underlying causes that led to the leakage from a high-pressure hose were a component design insufficient (code 5308) and a maintenance program inadequate (codes 5303 and 5313).

Appendix Full Report B / area concerned - remarks:

In the Original Report there is no evidence of significant effects outside the establishment, except the breakage of a few windows at neighbours caused by the explosions.

Appendix Full Report B / people:

Inside the establishment, one operator was injured (and hosptalized but for observation for shock only) 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 explosions and the followinf fires damaged the building, the cylinders filling equipment and the pressure cylinders. The cost of the damages has been evaluated in about 3.6 millions DKR (about 0.5 MECU). Outside the establishment a few windows were broken by the explosions but no data are available about their cost.

Appendix Full Report B / disruption of community life:

In the Original Report there is no evidence of significant effects outside the establishment, except the breakage of a few windows in the neighbours caused by the explosions.

Appendix Full Report C / lesson learned - prevent:

After the accident, it was decided that in rebuilding the installation and reconstruction of equipment for cylinders filling:

1- the design of piping and piping components should be improved;

2- the maintenance program shoud be improved.

Appendix Full Report C / lesson learned - mitigate:

After the accident, it was decided that in rebuilding the installation and reconstruction of equipment for cylinders filling:

1- overpressure protection of the acetylene compressors shoud be improved;

2- a new sprinkler system for the cylinder filling facility will be installed;

3- the emergency planning should be improved.