

# Explosion i krackningsanläggningen på en petrokemisk anläggning.

920109 MARS 1992\_20

Olyckan inträffade i krackningsanläggningen på en petrokemisk fabrik. Vid ett produktionsstopp avsåg man att se över återvinningen av katalysator från den katalytiska krackningen.

Underhållsarbetare demonterade utrustningen efter rutinmässiga metoder. Emellertid hade ovanligt stora mängder oregenererad katalysator ansamlats i det aktuella kärlet. När den andra av två manluckor skulle öppnas hördes ett mullrande inifrån kärlet omedelbart då den första bulten lossades. Plötsligt slog lågor ut genom luckan och svepte in arbetarna i lågor. Vittnen säger att de sekunder senare hörde en andra explosion. Denna inträffade när stötvågen från den första explosionen träffade en kokare 30 m bort. Man fann att katalysatorn var kontaminerad och att en explosiv atmosfär uppstått inne i återvinningskärlet. När syre strömmade till genom den öppnade luckan uppstod explosionen.

## Inblandade ämnen och mängder

|                                    | CAS Nr.   | Mängd |
|------------------------------------|-----------|-------|
| aluminium silikat<br>(katalysator) | 1302-76-7 | okänt |
| tunga kolväteoljor                 |           | okänt |
| väte                               | 1333-74-0 | okänt |
| kolmonoxid                         | 630-08-0  | okänt |
| lätta kolvätegaser                 |           | okänt |

## Skador:

**Människor:** 24 människor på anläggningen skadades av explosionen. 8 av dem fick stanna på sjukhus. 2 av dem förflyttades med brännskador till ett annat sjukhus.

**Materiella:** Krackningsanläggningen skadades.

**Miljö/ekologi:** Inga effekter rapporterade.

**Infrastruktur:** Inga.

## Erfarenheter redovisade (Ja/Nej): Ja

Kortfattat anges förebyggande åtgärder.

## Report Profile

### Identification of Report:

country: FA ident key: 1992\_020\_01

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

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

start: 1992-01-09 start: 17:00:00

finish: finish:

### Establishment:

name:

address:

industry: 2002 petrochemical, refining, processing

Petroleum Refinery (Fluidised Catalytic Cracker Unit [FCCU])

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\_020\_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: No explosive: Yes

ecotoxic: No other: No

flammable: Yes

description:

- Aluminium Silicate Catalyst (C.A.S. CODE: 1302-76-7): 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 the shut-down of the Fluidised Catalytic Cracker Unit (FCCU) in a petroleum refinery.

The FCCU is used to crack heavy hydrocarbon oils producing light oils and gases. The component involved was

the catalyst regenerator... see Appendix Short Report / description of immediate sources

## **Suspected Causes:**

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

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

**description:**

INITIATING EVENTS AND CONSEQUENCES:... see Appendix Short Report / description of suspected causes

## **Immediate Effects:**

**material loss:** Yes

**human deaths:** No

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

**other:** No

**ecological harm:** No

**national heritage loss:** No

**description:**

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

## **Emergency Measures taken:**

**on-site systems:** Yes **decontamination:** No

**external services:** Yes **restoration:** No

**sheltering:** No **other:** No

**evacuation:** No

**description:**

INTERNAL TO THE ESTABLISHMENT:... see Appendix Short Report / description of emergency measures taken

## **Immediate Lessons Learned:**

**prevention:** Yes **other:** No

**mitigation:** No

**description:**

LESSONS TO PREVENT RECURRENCE:... see Appendix Short Report / description of immediate lessons learned

# **A Occurrence Full Report**

**country:** FA **ident key:** 1992\_020\_01

## **1 Type of Accident**

**remarks:** During the shut-down of the Fluidised Catalytic Cracker Unit (FCCU), it was decided to monitor the conditions of a new equipment configuration that was installed within the catalyst regenerator. To allow the access into the regenerator, two... see Appendix Full Report A / type of accident

## **2 Dangerous Substances**

**remarks:** The aluminium silicate catalyst contained in the regenerator was contaminated with hydrocarbon oils. At the high temperature of the regenerator and in an oxygen deficient atmosphere, it gave rise to hydrogen, light hydrocarbon gases and car... see Appendix Full Report A / dangerous

substances

### 3 Source of Accident

**illustration:** - not applicable -

**remarks:** The accident occurred in the Fluidised Catalyst Cracker Reactor Unit (FCCU)

of a petroleum refinery (code 2002). The FCCU was used to crack heavy

hydrocarbon oils producing light oils and gases (code 3102). The component

involved was the ca... 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:** The accident occurred in the evening and, therefore, it was dark.

### 5 Causes of Major Occurrence

**main causes**

**technical / physical** 5107 operation: unexpected reaction/phase-transition

- not applicable -

- not applicable -

- not applicable -

- not applicable -

**human / organizational** 5302 organization: management attitude problem

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 -

**remarks:** The explosion was probably caused by a mixture of H<sub>2</sub>, light hydrocarbon gases and CO

unexpectedly formed due to a high temper. in the regenerator in a poor oxygen atmosphere

(code 5107). This mixture was above its auto-ignition temperature ... see Appendix Full

Report A / causes of major occurrence

### 6 Discussion about the Occurrence

- not applicable -

**Type of Accident** country: FA ident key: 1992\_020\_01

**event:**

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

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

associated event - not applicable -

## **Dangerous substances**

country: FA ident key: 1992\_020\_01

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

CAS number: identity: Petroleum Gases

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: 1333-74-0 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: 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: identity: Heavy Hydrocarbon Oils

name from Seveso I Directive: - not applicable -

name from Seveso II Directive: - not applicable -

category from Seveso II: - not applicable -

other hazards (1): - not applicable -

other hazards (2): - not applicable -

maximum quantity (tonnes): -1

use of substance as: STARTING MATERIAL

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

actual quantity: -1 potential quantity: -1

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

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

**a) total establishment inventory**

CAS number: 630-08-0 identity: Carbon 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

**a) total establishment inventory**

CAS number: 1302-76-7 identity: Aluminium Silicate Catalyst

name from Seveso I Directive: - not applicable -

name from Seveso II Directive: - not applicable -

category from Seveso II: - not applicable -

other hazards (1): - not applicable -

other hazards (2): - not applicable -

maximum quantity (tonnes): -1

use of substance as: STARTING MATERIAL

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

actual quantity: -1 potential quantity: -1

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

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

**Source of Accident - Situation** country: FA ident key: 1992\_020\_01

**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:** 1992\_020\_01

### 1 Area concerned

**affected**

**extent of effects installation:** Yes

**establishment:** No

**off-site; local:** No

**off-site; regional:** No

**off-site; transboundary:** No

**illustration of effects** - not applicable -

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

Full Report B / area concerned - remarks

### 2 People

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

**total at risk** 24

**immediate fatalities**

**subsequent fatalities**

**hospitalizing injuries** 10

**other serious injuries** 14

**health monitoring**

**remarks** Inside the establishment 24 people were injured by the explosion. Of these, 8 pe... 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 explosion caused minor damages around the 60" man-way but extensive damages ... see Appendix

Full Report B / material loss

#### **6 Disruption of Community Life**

**establishment/plant evacuated disabled/unoccupiable destroyed**

- **nearby residences/hotels** No No No

- **nearby factories/offices/small shops** No No No

- **schools, hospitals, institutions** No No No

- **other places of public assembly** No No No

**interruption of utilities etc. no / yes duration**

- **gas** No

- **electricity** No

- **water** No

- **sewage treatment works** No

- **telecommunications** No

- **main roads** No

- **railways** No

- **waterways** No

- **air transport** No

**significant public concern none local level national level**

- **off site populations** Yes No No

- **media interest** No No No

- **political interest** No No No

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

#### **7 Discussion of Consequences**

# C Response Full Report

country: FA ident key: 1992\_020\_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\_020\_01 report

## Appendix Short Report / description of accident types:

### ACCIDENT CASE HISTORY DESCRIPTION:

The Fluidised Catalytic Cracker Unit (FCCU) was shut-down because of the failure of the air blowers that provided the oxygen to regenerate the catalyst in the regenerator. It was decided that the shut-down would be an opportunity to conduct some repairs and maintenance and also to monitor the condition of a new equipment configuration that had been recently installed within the regenerator. The catalyst was removed from the base of the generator by a nitrogen assisted steam reduction system until the entry into vessel was possible. The vessel was isolated in preparation (270 blinds had to be inserted before operational procedures allowed entry). The operational procedures that were followed were those that had been successfully used before. Although, it is now realized that they did not take into account the particular set of conditions (that is the large amount of un-regenerated catalyst) in this instance. At approximately 17:30 on Thursday 9, January, fitters started to remove 2 man-way covers on the generator. First a 30" cover was removed to allow a preliminary visible inspection. No gas tests were made prior to opening as the system was considered to be open to atmosphere because of its flue to the stack. However, the removal of a valve and flow nozzle in the flue duct work may have reduced the draw of the flue on the regenerator and, therefore, contributed to an oxygen deficiency in the regenerator. The first cover was removed without mishap and the fitters proceeded to open a second 60" man-way which was just being held by 2 bolts and a block and tackle. One bolt was removed when witnesses heard a rumbling noise from inside the regenerator. This was immediately followed by an orange-red flash came out on the left side of the man-way flange engulfing the group of workers on that side. After a few seconds, witnesses heard a second loud explosion. It occurred when the pressure wave from the first explosion reached the waste heat boiler (about 30 metres away) connected to the regenerator by a pipework.

## Appendix Short Report / description of substances involved:

- Aluminium Silicate Catalyst (C.A.S. CODE: 1302-76-7): amount involved = not known.

(The catalyst was contaminated with heavy hydrocarbon oils that at the high temperature of the regenerator and in an poor oxygen atmosphere gave rise to hydrogen, carbon monoxide and light hydrocarbon gases that formed an explosive mixture).

- Heavy Hydrocarbon Oils: amount involved = not known.

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

- Carbon Monoxide (C.A.S. CODE: 630-08-0): amount involved = not known.

- Light Hydrocarbon Gases: amount involved = not known.

## Appendix Short Report / description of immediate sources:

The accident occurred the shut-down of the Fluidised Catalytic Cracker Unit (FCCU) in a petroleum refinery. The FCCU is used to crack heavy hydrocarbon oils producing light oils and gases. The component involved was the catalyst regenerator.

## Appendix Short Report / description of suspected causes:

### INITIATING EVENTS AND CONSEQUENCES:

During the shut-down of the Fluidised Catalytic Cracker Unit, it was decided to make some repairs and maintenance and to monitor the condition of a new equipment configuration that was installed within the catalyst regenerator. To allow the access into the regenerator, two man-ways were removed and this provided an oxygen entry which produced an explosive mixture with the gases from the contaminated catalyst. The flammable mixture was then ignited and a confined explosion occurred.

### CAUSES:

The initial failure of the blowers was caused by vibration to the blower turbine due to loose objects contacting the turbine blades. It has been assumed that these objects came from the actual engineering materials of the turbine itself.

The explosion was probably caused by a mixture of hydrogen, light hydrocarbon gases and carbon monoxide. This mixture was either above its auto-ignition temperature during the oxygen entry (when the man-way covers were removed) or was ignited by pyrophoric carbon deposits. The evolution of these gases was stimulated by the action of steam on the un-regenerated catalyst in an poor oxygen atmosphere (this reaction was discovered in subsequent laboratory experiments). This steam was injected immediately after the crash shut-down in an attempt to regenerate the catalyst and keep the catalyst bed fluid. The opening of the man-ways allowed sufficient oxygen enrichment for an explosive mixture in the previously stagnant internal regenerator atmosphere. This stagnation has thought to have occurred because of the new internal plant configuration which prevented the gases rising and escaping from the top flue and also because of the reduced flue draw caused by the removal of a valve and a nozzle in the ducts between the flue and the stack.

## Appendix Short Report / description of immediate effects:

#### EFFECTS ON PEOPLE:

Inside the establishment, 24 people were injured by the explosion. Of these, 8 people were detained in the hospital and 2 of whom were transferred to the Burns Unit at the St. Lawrence Hospital in Chepstow.

#### MATERIAL LOSS:

The explosion caused minor damages around the 60" man-way but extensive damages to the waste heat boiler. No data are available about the cost of the damages.\_

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

##### INTERNAL TO THE ESTABLISHMENT:

The full site was alerted of the emergency. Water monitor sprays were trained onto the regenerator after the explosion. Approximately 70 people were involved in dealing with the accident.

##### EXTERNAL TO THE ESTABLISHMENT:

The County Emergency Services were summoned.

#### **Appendix Short Report / description of immediate lessons learned:**

##### LESSONS TO PREVENT RECURRENCE:

After the accident, the following measures were established:

- 1- in future, the catalyst will be cooled to 400°C before its unloading from the regenerator prior to entry the vessel;
- 2- gas composition in the regenerator will be identified before the removal of the two man-way covers;
- 3- the entry into any equipment on the catalyst circuit will be prohibited if the blower powdered by powder recovery train fails and, therefore, the proper purging of the regenerator has not occurred;
- 4- if purging would be necessary, it will be done using large quantities of steam over a long period of time to fluidise the catalyst bed and promote the reactions that caused the accident removing these dangerous by-products. This will also cool the catalyst bed;
- 5- tighter control on personnel around future openings of man-ways.

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

During the shut-down of the Fluidised Catalytic Cracker Unit (FCCU), it was decided to monitor the conditions of a new equipment configuration that was installed within the catalyst regenerator. To allow the access into the regenerator, two man-ways were removed and this provided an oxygen entry which formed an explosive atmosphere with the gases from contaminated catalyst. The flammable mixture was then ignited and a confined explosion occurred (code 1307).

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

The aluminium silicate catalyst contained in the regenerator was contaminated with hydrocarbon oils. At the high temperature of the regenerator and in an oxygen deficient atmosphere, it gave rise to hydrogen, light hydrocarbon gases and carbon monoxide. The accurate composition and the amounts of the substances involved in the accident are unknown.

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

The accident occurred in the Fluidised Catalyst Cracker Reactor Unit (FCCU) of a petroleum refinery (code 2002). The FCCU was used to crack heavy hydrocarbon oils producing light oils and gases (code 3102). The component involved was the catalyst regenerator (code 4007). The accident occurred during the shut-down of the FCCU, that would be an opportunity to conduct some repairs and maintenance and also to monitor the conditions of a new configuration installed within the regenerator.

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

The explosion was probably caused by a mixture of H<sub>2</sub>, light hydrocarbon gases and CO unexpectedly formed due to a high temper. in the regenerator in a poor oxygen atmosphere (code 5107). This mixture was above its auto-ignition temperature or was ignited by pyrophoric carbon deposits (code 5307). The operational procedures followed did not take into account the large amounts of un-regenerated catalyst (codes 5302 and 5303). The new internal plant configuration was not correct (code 5308).

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

In the Original Report there is no evidence of significant effects outside the Fluidised Catalytic Cracker Unit.

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

Inside the establishment 24 people were injured by the explosion. Of these, 8 people were detained in hospital and 2 of them were transferred to the Burns Unit at St. Lawrence Hospital in Chepstow. Approximately 70 people were involved in dealing with the accident.

#### **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 explosion caused minor damages around the 60" man-way but extensive damages to the waste heat boiler. No data are available about the cost of the damages.

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

In the Original Report there is no evidence of significant effects outside the Fluidised Catalytic Cracker Unit.

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

After the accident, the following measures were established:

- 1- the catalyst will be cooled in future to  $400^{\circ}\text{C}$  before its unloading prior to entry;
- 2- gas composition in the catalyst regenerator will be identified before the removal of the two man-way covers;
- 3- the entry into any equipment of the catalyst circuit will be prohibited if the blower powered by power recovery train fails and, therefore, the proper purging of the regenerator had not occurred;
- 4- if purging would be necessary, it will be done using large quantities of steam over a long period of time to fluidify the catalyst bed and promote the reactions that cause the accident removing these dangerous by-products. This will also cool the catalyst bed.
- 5- tighter control on personnel around future openings of man-way covers.