

Report Profile

Identification of Report:

country: SW ident key: 1995_001_01

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

Date of Major Occurrence: Time of Major Occurrence

start: 09/05/1995 start: 13:45:00

finish: 09/05/1995 finish: 14:30:00

Establishment:

name: Ferriklor AB

address: Närkes Kvarntorp, 692 01 Kumla, Sweden.

industry: 2001 general chemicals manufacture

Chemical

Seveso II status: not applicable: Yes art. 6 (notification): No

art. 7 (MAPP): No

art. 9 (safety report): No

Date of Report:

short: 03/08/1998 full: 03/08/1998

Authority Reporting:

name: Swedish Rescue Services Agency

address: Karolinen, 651 80 Karlstad, Sweden

Authority Contact:

rep_cont_name: Lena Tellvik

rep_cont_phone: +46-54-10 40 00

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Additional Comments:

- a) On the afternoon of the 9th of may 1995, there was a release of hydrogen sulphide gas at a plant, which resulted in the death of two process workers. The release occurred at a plant for the production of ferric chloride from waste pickling ... see Appendix Profile Text a
- b) The time of "major occurrence - finish" which has been stated is the time when the municipal Rescue Service had concluded that the two process operators were deceased.
- c) The site is covered by the Seveso I directive because of the use of chlorine.
- d) - not applicable -
- e) - not applicable -

Short Report

country: SW ident key: 1995_001_01

Accident Types:

release: Yes **explosion:** No

water contamination: No **other:** No

fire: No

description:

Unexpected release of hydrogen sulphide gas occurred at a plant for production of ferric chloride from waste pickling solution. Two workers were manually adding solid phase sodium sulphide to a liquid phase pickling solution. The release occ... see Appendix Short Report / description of accident types

Substance(s) Directly Involved:

toxic: Yes **explosive:** No

ecotoxic: No **other:** No

flammable: No

description:

Hydrogen sulphide in the gas phase, H₂S, is a colourless gas with an odour of rotten eggs. The gas is poisonous and rapidly lethal if inhaled. Ihl-hmn LCLo:800 ppm/5 min.

Immediate Sources of Accident:

storage: No **transfer:** No

process: Yes **other:** No

description:

The accident occurred because solid phase sodium sulphide was added at a much to low pH value in excess quantities. No proper pH check of the solution.

Suspected Causes:

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

human: Yes **other:** Yes

description:

The human factor and lack of chemical-technical knowledge. Among other things no proper pH check of the spent pickling solution was carried out. Inadequate management procedures, the work carried out in an improvised manner instead of follo... see Appendix Short Report / description of suspected causes

Immediate Effects:

material loss: No

human deaths: Yes

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

other: No

ecological harm: No

national heritage loss: No

description:

The two process workers were immediately killed due to the inhalation of hydrogen sulphide gas.

Emergency Measures taken:

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

external services: Yes **restoration:** No

sheltering: No **other:** No

evacuation: No

description:

The municipal rescue service arrived on scene about 15-20 minutes after the incident efforts were made to revive the two process workers but to no avail. The clothes of the two process operators were cut open and removed from their bodies s... see Appendix Short Report / description of emergency measures taken

Immediate Lessons Learned:

prevention: Yes **other:** No

mitigation: No

description:

Spent pickling solutions to which sodium sulphide is to be added (for precipitation of heavy metals) must be properly pH checked prior to addition of sodium sulphide. The pH value must be at least 4.5. It is of paramount importance that firm... see Appendix Short Report / description of immediate lessons learned

A Occurrence Full Report

country: SW **ident key:** 1995_001_01

1 Type of Accident

remarks: 1101, unexpected release of hydrogen sulphide gas, killing two process operators. The initial concentration of the released gas was at least 1000 ppm. 1999, the initiating event was the addition of solid phase sodium sulphide to liquid phas... see Appendix Full Report A / type of accident

2 Dangerous Substances

remarks: The accident investigation team concluded that about 60 kg of hydrogen sulphide gas had evolved. If the remaining sacks of sodium sulphide, on the sack stool, had been added the evolved amount of hydrogen sulphide would have been about 90 k... see Appendix Full Report A / dangerous substances

3 Source of Accident

illustration: No illustration provided.

remarks: The hydrogen sulphide gas evolved from the open tops of two reaction vessels which are of the vertical cylindrical type, with garting across their tops. Each reaction vessel has a volume of 34 cubic meters. Their open tops are about 6 meter... see Appendix Full Report A / source of accident - remarks

4 Meteorological Conditions

precipitation none: fog: rain: hail: snow:

Yes No No No No

wind speed (m/s): 2.6

direction (from): north

stability (Pasquill): stable

ambient temperature (°C): 10

remarks: Sunny day, with clear sky and steady wind.

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

- not applicable -

- not applicable -

- not applicable -

- not applicable -

remarks: No proper pH value check was made of the spent pickling solutions, in the reaction

vessels, into which sodium sulphide was added. Various inappropriate, temporary

arrangements were used in order to facilitate the adding of sodium sulphide. ... see

Appendix Full Report A / causes of major occurrence

6 Discussion about the Occurrence

The human factor and lack of chemical-technical knowledge. Among other things no proper pH check of the

spent pickling solutions was carried out. Inadequate management procedures, the work carried out in an

improvised manner instead of foll... see Appendix Full Report A / discussion about the occurrence

Type of Accident country: SW ident key: 1995_001_01

event:

major occurrence 1101 release: gas/vapour/mist/etc release to air

initiating event 1999 other: other

associated event - not applicable -

Dangerous substances

country: SW ident key: 1995_001_01

a) total establishment inventory

CAS number: 7783-06-4 **identity:** possible abnormal product

name from Seveso I Directive: Hydrogen sulphide

name from Seveso II Directive: - not applicable -

category from Seveso II: very toxic

other hazards (1): extremely flammable gases and liquids

other hazards (2): - not applicable -

maximum quantity (tonnes): 0.1

use of substance as: possible abnormal product

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 0.06 **potential quantity:** 0.09

c) substance belongs to relevant inventory indirectly involved: Yes

actual quantity: 0 **indir_pot_quant:** 0.01

Source of Accident - Situation **country:** SW **ident key:** 1995_001_01

situation

industry

initiating event - not applicable -

associated event - not applicable -

activity/unit

major occurrence 3101 process: chemical batch reaction

initiating event - not applicable -

associated event - not applicable -

component

major occurrence 4001 reaction vessel; non-pressurised

initiating event 4999 other

associated event - not applicable -

B Consequences Full Report

country: SW **ident key:** 1995_001_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 No illustration provided.

remarks The evolved hydrogen sulphide gas dissipated in the atmosphere to a non dangerous... see Appendix

Full Report B / area concerned - remarks

2 People

establishment popul. emergency personnel off-site population

total at risk 3 0 0

immediate fatalities 2 0 0

subsequent fatalities 0 0 0

hospitalizing injuries 0 0 0

other serious injuries 0 0 0

health monitoring 3 8 0

remarks The person who went to look for the process operators that did not come down fro... see Appendix

Full Report B / people

3 Ecological Harm

pollution/contamination/damage of:

- residential area (covered by toxic cloud) No
- common wild flora/fauna (death or elimination) No
- rare or protected flora/fauna (death or elimination) No
- water catchment areas and supplies for consumption or recreation No
- land (with known potential for long term ecological harm or

preventing human access or activities)

- marine or fresh water habitat No
- areas of high conservation value or given special protection No

remarks No ecological harm of any significance occurred, since the evolved hydrogen sulph... see Appendix

Full Report B / ecological harm

4 National Heritage Loss

effects on:

- historical sites None - historic monuments None
- historic buildings None - art treasures None

remarks - not applicable -

5 Material Loss

establishment losses off site losses

costs (direct costs to operator) (social costs)

in ECU SEK ECU SEK

material losses 0 0 0 0

response, clean up, restoration 0 10000 0 200000

remarks Off site losses due to rescue activities and social costs associated with the tw... 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 Yes

- political interest No Yes No

remarks Significant media interest was reported. To some extent this media interest dist... see Appendix

7 Discussion of Consequences

Ecological Components involved

country: SW **ident key:** 1995_001_01

type: - not applicable -

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

C Response Full Report

country: SW **ident key:** 1995_001_01

1 Emergency Measures

taken - on site 7202 external services: external 7701 other: health

ambulance/victim-recovery services monitoring/epidemiology

- not applicable - - not applicable -

- not applicable - - not applicable -

- **off site** 7203 external services: police - not applicable -

intervention

- not applicable - - not applicable -

- not applicable - - not applicable -

still - on site 7101 internal systems: - not applicable -

required management/organization review

- not applicable - - not applicable -

- not applicable - - not applicable -

- **off site** 7207 external services: crowd control - not applicable -

- not applicable - - not applicable -

- not applicable - - not applicable -

continuing contamination or danger

-**on site** No

-**off site** No

remarks From the factory the national ... see Appendix Full Report C / emergency measures

2 Seveso II Duties

pre-accident evaluation

Article item not due yet not done done/submitted evaluated

6 notification Yes No No No

7 policy (MAPP) Yes No No No

9 safety report Yes No No No

9, 10, 11 update Yes No No No

11 internal plan Yes No No No

11 external plan Yes No No No

13 informing public Yes No No No

9, 12 siting policy Yes 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) No No Less

9 current safety report No No Less

11 internal plan No No Less

11 external plan No No Less

13 informing public No No Less

9, 12 siting policy No No Less

evaluation of safety organisation

organisational element element existed did element relate to actual circumstances of

yes / no no / partly / yes adequate?

- written policy objectives Yes Partly Yes

- specified management Yes Yes Yes

structure

- specified responsibilities Yes Yes Yes

- specified working procedures Yes Yes Yes

- specified procedures for No

assessment/auditing of

management system

- specified procedures for No

review and update of

management policy

- specified general training Yes No Yes

procedures

- specified emergency Yes No Yes

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 When the accident occurred Seve... see Appendix Full Report C / Seveso II duties

3 Official Action Taken

legal action

The court fined Ferriklor AB 7... see Appendix Full Report C / official action taken - legal

other official action

Investigation reports from the... see Appendix Full Report C / official action taken - other

4 Lessons Learned

measures to prevent recurrence

Improved management routines a... see Appendix Full Report C / lesson learned - prevent

measures to mitigate consequences:

Psychological counselling of c... see Appendix Full Report C / lesson learned - mitigate

useful references:

Both reports, mentioned under ... see Appendix Full Report C / lesson learned - references

5 Discussion about Response

Appendices for the SW / 1995_001_01 report

Appendix Profile Text a:

On the afternoon of the 9th of may 1995, there was a release of hydrogen sulphide gas at a plant, which resulted in the death of two process workers. The release occurred at a plant for the production of ferric chloride from waste pickling solutions. The two workers were manually adding solid phase sodium sulphide to a liquid phase pickling solution. The pH value of the pickling solution was much too low and too much sodium sulphide was added. Therefore instead of the expected chemical reaction (precipitation) an unexpected reaction (formation of hydrogen sulphide gas) occurred.

Appendix Short Report / description of accident types:

Unexpected release of hydrogen sulphide gas occurred at a plant for production of ferric chloride from waste pickling solution. Two workers were manually adding solid phase sodium sulphide to a liquid phase pickling solution. The release occurred because the pH value of the solution was too low and too much sodium sulphide was added.

Appendix Short Report / description of suspected causes:

The human factor and lack of chemical-technical knowledge. Among other things no proper pH check of the spent pickling solution was carried out. Inadequate management procedures, the work carried out in an improvised manner instead of following working procedures. Inadequate supervision of how the work was actually carried out and a lack of safety culture. The activity of the establishment was not in accordance with the licence issued on the basis of the Environmental Protection Act.

Appendix Short Report / description of emergency measures taken:

The municipal rescue service arrived on scene about 15-20 minutes after the incident efforts were made to revive the two process workers but to no avail. The clothes of the two process operators were cut open and removed from their bodies since their clothes were to some extent suspected of serving as a poisonous gas trap. The two process operators were rushed by ambulance to a nearby hospital where doctors concluded that the two operators had deceased. Storage of the bodies at the hospital caused some problems because they emitted large amounts of H₂S.

Appendix Short Report / description of immediate lessons learned:

Spent pickling solutions to which sodium sulphide is to be added (for precipitation of heavy metals) must be properly pH checked prior to addition of sodium sulphide. The pH value must be at least 4.5. It is of paramount importance that firm, well planned working procedures are adhered to in this type of industry. Improvised procedures introduce great risk.

Appendix Full Report A / type of accident:

1101, unexpected release of hydrogen sulphide gas, killing two process operators. The initial concentration of the released gas was at least 1000 ppm. 1999, the initiating event was the addition of solid phase sodium sulphide to liquid phase spent pickling solutions, which had far too low a pH value . The intention was to precipitate heavy metals in the solution. However, the very low pH value induced formation of hydrogen sulphide gas rather than precipitation of heavy metals.

Appendix Full Report A / dangerous substances:

The accident investigation team concluded that about 60 kg of hydrogen sulphide gas had evolved. If the remaining sacks of sodium sulphide, on the sack stool, had been added the evolved amount of hydrogen sulphide would have been about 90 kg. Under slightly different conditions regarding ambient air temperature, solution, pH etc an additional 10 kg of hydrogen sulphide might have evolved.

Appendix Full Report A / source of accident - remarks:

The hydrogen sulphide gas evolved from the open tops of two reaction vessels which are of the vertical cylindrical type, with grating across their tops. Each reaction vessel has a volume of 34 cubic meters. Their open tops are about 6 meters above ground level. Each reaction vessel is equipped with one electrically powered mixer attached to the grating at the top of the vessel. The two process plant operators who were killed were standing on the top of the grating, charging solid phase sodium sulphide to the spent pickling solutions in the vessels.

Appendix Full Report A / causes of major occurrence:

No proper pH value check was made of the spent pickling solutions, in the reaction vessels, into which sodium sulphide was added. Various inappropriate, temporary arrangements were used in order to facilitate the adding of sodium sulphide. Therefore the roof covering directly above the reaction vessels was removed and a temporary ladder arrangement was in place in order to facilitate human access to the top of the reaction vessels.

Appendix Full Report A / discussion about the occurrence:

The human factor and lack of chemical-technical knowledge. Among other things no proper pH check of the spent pickling solutions was carried out. Inadequate management procedures, the work carried out in an improvised manner instead of following established procedures. Inadequate supervision of how the work was actually carried out and a lack of safety culture. The activity of the establishment was not in accordance with the licence issued on the basis of the Environmental Protection Act.

Appendix Full Report B / area concerned - remarks:

The evolved hydrogen sulphide gas dissipated in the atmosphere to a non dangerous concentration within a few minutes.

Appendix Full Report B / people:

The person who went to look for the process operators that did not come down from the grating at the top of the reactor vessels, was himself potentially at risk, since he did not know about the evolved hydrogen sulphide gas.

Appendix Full Report B / ecological harm:

No ecological harm of any significance occurred, since the evolved hydrogen sulphide gas dissipated within a few minutes into the atmosphere.

Appendix Full Report B / material loss:

Off site losses due to rescue activities and social costs associated with the two deceased process operators.

Appendix Full Report B / disruption of community life:

Significant media interest was reported. To some extent this media interest disturbed the psychological counselling of the co-workers of the deceased process operators. The Swedish Board of Accident Investigation pointed out that in this type of situation a responsible person should be appointed to deal with the media.

Appendix Full Report B / discussion of consequences:

The accident and associated negative effects stem from inadequate management procedures which made it possible for staff to conduct work in an improvised manner characterized by many inappropriate temporary arrangements, and insufficient checking of parameters (especially solution pH) of vital importance.

Appendix Full Report C / emergency measures:

From the factory the national emergency alarm centre was phoned as soon as the accident had been detected. The emergency centre sent out the local Rescue Service, a staffed ambulance, and notified the local hospital via telefax.

Appendix Full Report C / Seveso II duties:

When the accident occurred Seveso II was not applicable.

Appendix Full Report C / official action taken - legal:

The court fined Ferriklor AB 750.000 SEK for breaking The Occupational Safety and Health Act. They also fined the Director 14.000 SEK and gave him a conditional sentence.

Appendix Full Report C / official action taken - other:

Investigation reports from the Swedish Board of Accident Investigation and the Swedish National Labour Inspectorate have been prepared. The latter contains photographs from the scene.

Appendix Full Report C / lesson learned - prevent:

Improved management routines and improved safety training of the staff were found to be necessary. A review is also necessary in order to check if there are more critical parameters which should be analysed on a routine basis in order to ensure safety and minimize risks. The entire staff at the process factory in question need to change their attitude in a direction which caters for more consideration of safety and risk related aspects. The accident also highlights the difficulties of assessing staff education, general knowledge and experience in safety matters for the authorities.

Appendix Full Report C / lesson learned - mitigate:

Psychological counselling of co-workers and relatives of the deceased took place soon after the accident had occurred.

Appendix Full Report C / lesson learned - references:

Both reports, mentioned under 3b, are at present only available in Swedish.

Appendix Full Report C / discussion about response:

The immediate response to the accident was in general carried out rapidly and professionally by the local Rescue Service, the ambulance team, and the psychological counselling team. Some questions were raised about the hospital's handling of the bodies, since they emitted large amounts of hydrogen sulphide gas.