Spill of heavy fuel oil in an oil terminal

21 June, 2003

Oil harbour of Göteborg - Sweden

Surface water contamination
Flammable liquids farm
Storage tank
Manhole
Heavy fuel oil
Maintenance
Procedures

THE INSTALLATIONS IN QUESTION

The accident happened at an oil terminal in the oil harbour of Göteborg, Sweden. The oil terminal is one of several oil terminals and oil storage companies in the oil harbour. It handles mainly petroleum products, of category 1, 2 and 3 inflammable liquids. It has a storage capacity of approximately 700 000 cbm, in 160 storage tanks and a few rock caverns, and is classified as a “Seveso II” company at the higher level according to the “Seveso II” European directive.

The oil harbour is located in the port of Göteborg at the estuary of the river Göta Älv at the west coast of Sweden. The oil harbour is responsible for the common service systems outside each oil terminal. The rain water drainage systems from the oil terminals end up in the harbour rain water drainage system. The rain water passes a contol basin, K1, a gravity separator and goes through a tunnel and a caisson to the estuary of the river Göta Älv in the open harbour.

THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident:

At Saturday night 21 June, on Midsummer Eve holiday in Sweden, there was a spill of 328 metric tons of heavy fuel oil in the oil terminal during discharge of the product from a ship vessel to a storage tank. Approximately 50 tons of the heavy fuel oil reached the recipient. The oil passed the rain water drainage system, reached the open sea and contaminated beaches and seashores in the coast archipelago outside Göteborg.

On Friday 20 June 22.30 p.m., after a maintenance work, the discharge of heavy fuel oil from a ship vessel to storage tank No 375 was started by two operators. At the same time discharging to tank No 304 was ongoing.

At Saturday 21 June 00.30 a.m. when reading the level indicator the operators noticed that the level in tank No 375 did not continue to increase. The operators tried to increase the flow to tank No 375 by reducing the valve to tank No 304.

At 01.52 a.m. the operators discovered that the manhole of tank No 375 was open and oil was flowing out to the ground outside the tank and to a neighbour company in the harbour. The operators closed the valve to tank No 375 and also the manhole.

Oil spill outside tank No 375 was spread on the surrounding ground. Under the pipe rack (in the left) there was a rain water drainage sewer.

Photo: the insurance company (21 June 2003).

At 02.00 a.m. the terminal manager and a local cleaning company were informed about the accident.

The terminal manager arrived at 02.30 a.m., took over and informed the harbour service.

At 03.00 a.m. the cleaning operation started.

The ground at a neighbour company was filled with oil.
Photo: the insurance company.

At 03.15 a.m. the harbour service staff inspected the harbour rain water drainage system and closed the outlet from the rain water drainage system basin K1. The basin K1 was full of oil.

At 04.15 a.m. oil booms were placed in the open port harbour at the outlet from the rain water drainage system. Oil lumps could be seen in the rain water drainage system outlet caisson and there was oil in the skimmer.

Cleaning procedures continued during Saturday and the authorities were informed about the accident. The Fire Brigade was informed on Saturday morning and they did not notice any oil in the open sea. The first indication of large environmental effects of the oil spill came on Sunday morning 22 June when the Swedish Coast Guard noticed oil on the opposite side of the river estuary.

The consequences:

Human effects.

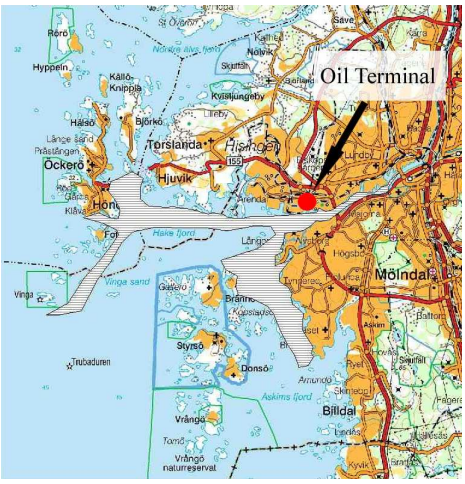
- ✓ There were no personal injuries.

Material effects.

- ✓ The spill resulted in a contaminated area in the harbour of approximately 2000 – 2500 sq metres including the oil terminal and two neighbour company sites.
- ✓ The heavy fuel oil contaminated the harbour open rain water drainage system and the harbour oil contaminated drainage water system.
- ✓ Fishermen tools were contaminated and hundreds of yachts in several Göteborg harbours were contaminated too.

Environmental effects.

- ✓ Approximately 50 metric tons of the spilled heavy fuel oil reached the recipient.
- ✓ The spill resulted in environmental damage of a wide area at the coast archipelago outside Göteborg. The sea water was contaminated with high polyaromatic hydrocarbon (PAH) containing oil, beaches were contaminated, a small number of sea birds died and many birds were contaminated.
- ✓ The emitted heavy fuel oil contained high amounts of toxic PAH´s. In July 2003 significantly high levels of PAH metabolites were found in eelpouts caught in the area close to Fiskebäck, south of Göteborg. In November 2003 the levels of PAH metabolites in eelpouts caught in the same area were not higher than in eelpouts from other areas. The PAH containing oil had severe local effects shortly after the spillage but most of the area seemed to be recovered in November 2003.



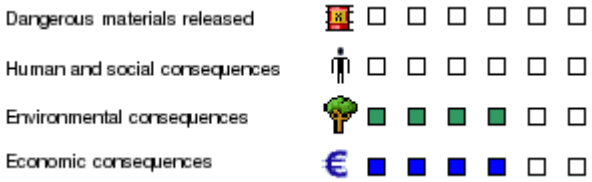
The area outlined on the map shows how the oil was spread in the coast archipelago outside Göteborg. The oil spread in two main directions, south and west from the harbour of Göteborg.

Economic consequences.

- ✓ The total economic loss for the oil terminal was approximately 2,7 millions of EUR.

European scale of industrial accidents:

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.



The parameters that comprise these indices and the corresponding rating method are available at the following address: http://www.aria.ecologie.gouv.fr.

The irrelevance of the index concerning the quantity of dangerous materials released (in the meaning of the SEVESO Directive parameter Q1) is based on Concawe classification recommendations for heavy fuel oils, risk phrases R52/R53, which is not classified as a Seveso substance. The heavy fuel oil which was released was not classified with risk phrases and therefore it is not clear if it was a Seveso substance or not.

The level 4 of environmental consequences is due to the length of the water front which was approximately 20 km (parameter Env14). There were also consequences of contaminated surface of soil at a level 1, approximateley 0,2-0,25 ha. (parameter Env13).

The level 4 given to the economic consequences is due to the high cost of the loss of 328 tons of product and to cleaning and decontaminations costs of total 25 million Swedish kronor, i.e. almost 2.7 million euros (parameter €16 and €18).

There were no noticeable consequences regarding human aspects.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The direct cause of the accident was the discharging of oil to a storage tank with an open manhole. The major latent factors which contibuted to the accident with the open manhole were :

- ✓ Communication. The accident happened after a shift take over after a maintenance work on the tank, and there was not enough information and communication between the two shifts.
- ✓ Operational procedures. Only a common practice procedure was available. Detailed check lists were missing for tank preparation and start-up process. Activities were carried out based on experience.
- ✓ Existing operational procedures were not followed and no double checks were made. The experienced operators did not double check the equipment before start-up. According to normal operation routine the operators should have done a control round out at the tank after the discharge had started. This check was not done.

Due to the Midsummer Eve holiday there were less personnel in the oil terminal than usual. The shift foreman was on vacation and the terminal manager had taken over the foreman's work.

The wide consequences of the accident were caused by a number of parameters :

- ✓ Wrong reaction. When the level in tank No 375 did not continue to increase the operators assumed there was some problem with the incoming flow. The operators did not go out and inspect the tank. Instead they increased the flow to tank No 375 by closing the valve to tank No 304. The oil was flowing out of the open manhole during one and a half hour before the operators went out to inspect the tank and discovered the open manhole.
- ✓ The normal emergency routines were not followed. According to harbour emergency plan, the harbour should be informed directly. It took more than one hour before the harbour staff was informed. When the harbour was informed the harbour staff inspected the rain water drainage basin K1 and noticed that it was filled with oil. Then the outlet of basin K1 was closed, too late.
- ✓ Cleaning activities started up early after the accident by the staff of the oil terminal. The behaviour of the operators and the terminal manager indicate that they were very stressed because of the accident. The Midsummer Eve holiday would also have some impact since the operating staff did not want to disturb people on vacation.
- ✓ The oil terminal is an old installation and therefore there were no bunds around the tank area where the accident occurred. The spilled oil was spread over a wide area on the surrounding ground. In a low point under a pipe rack close to the storage tank there was a rain water drainage sewer. A huge amount of heavy fuel oil reached the harbour rain water drainage system.
- ✓ There were no valves in the oil terminal rain water drainage system and therefore no possibility to shut off the contaminated part of the rain water drainage system.
- ✓ The density of this heavy fuel oil was higher than the density of water. The rain water drainage system is designed for oils lighter than water, based on gravity separators. There were no oil alarms installed in the rain water drainage system. The oil could not be seen on the surface in the open port and there were no specific routines for handling this kind of heavy fuel oil product.
- ✓ The booms that were placed in the open port harbour were not designed for heavy products. The heavy fuel oil formed clusters which were later detected between different layers of water where the river and the salt sea water meets, at 1-3 meters below the water surface in the river outside the harbour. Oil clusters were detected 2-10 meters below the surface in the sea south of Göteborg.

- ✓ The heavy fuel oil was probably mixed with lighter high aromatic oil and therefore the oil did not behave as expected. This heavy fuel oil formed clusters in the water and were spread over a wide area in the coast archipelago. The clusters dispersed and oil were detected on the sea water surface and on several beaches and harbours outside of Göteborg.

The oil formed clusters that did not float on the water. The diameter of the clusters was 3 to 10 centimetres. Photo: Swedish Coast Guard.

ACTIONS TAKEN

The accident occurred under normal operations, discharging of product from a ship vessel to a storage tank, and under normal conditions. The investigation team found five critical areas which were considered as relevant for actions:

- ✓ Operational procedures
- ✓ Emergency response
- ✓ Organisational related areas
- ✓ Communication
- ✓ Design

1. Operational procedures. Detailed procedures have been implemented for following operations:

- ✓ Detailed check list for shut down and preparation of equipment before start-up. Double checks between maintenace department and operating department.
- ✓ Detailed procedures for preparation of pump ways including all used pipes and tanks.
- ✓ One operator shall always be out at the tank at start of discharge until the tank level is above the manhole and above pipe connections and valves at the bottom of the tank.
- ✓ More routines and focus of the tank level increase rate have been implemented.
- ✓ A new routine for handling of heavy oil products has been implemented in the harbour system. The oil terminals have to inform the oil harbour staff before the arrival of ships with heavy oil products.
- ✓ Routines and procedures for work permit have been reviewed and improved.

2. Emergency response. The accident made it clear that the terminal staff did not fully understand what actions they were supposed to take in case of an emergency situation.

- ✓ The emergency plans of the oil harbour and the Oil terminal have been improved.
- ✓ A program for “Emergency response“ training is being implemented in the oil harbour together with the different oil terminals.
- ✓ The function of the tank level indication system has been clarified.

3. Organisational related areas. The accident showed that the operators had a tendency to use short cuts if possible. This behaviour indicated that there was a lack of risk and safety awareness in the oil terminal organisation.

- ✓ A yearly schedule for operator training has been implemented at the oil terminal.
- ✓ “Safety observation rounds” have been implemented at the oil terminal to verify safety awareness and that the operators work according to the procedures.
- ✓ The project “Safe Harbour” has been started in the oil harbour together with the different oil terminals. The project consists of 12 action areas of which some are described in this report.
- ✓ Different competence levels for all workers in the harbour have been defined and a safety course and “green card” for work in the harbour have been implemented.
- ✓ The involved terminal manager was replaced and lost his managing position. The involved operators were placed on daytime work after the accident. The CEO of the oil terminal lost his job due to the accident.

4. Communication.

- ✓ Routines for shift take over have been improved with a “shift take over checklist”.
- ✓ Emergency routines have been clarified at the oil terminal and at the oil harbour.

5. Design. The harbour systems are designed based on the principle that oil is lighter than water. The tank installations in the harbour are old and tank bunds are missing or are not sufficient in many cases. The following improvments have been made:

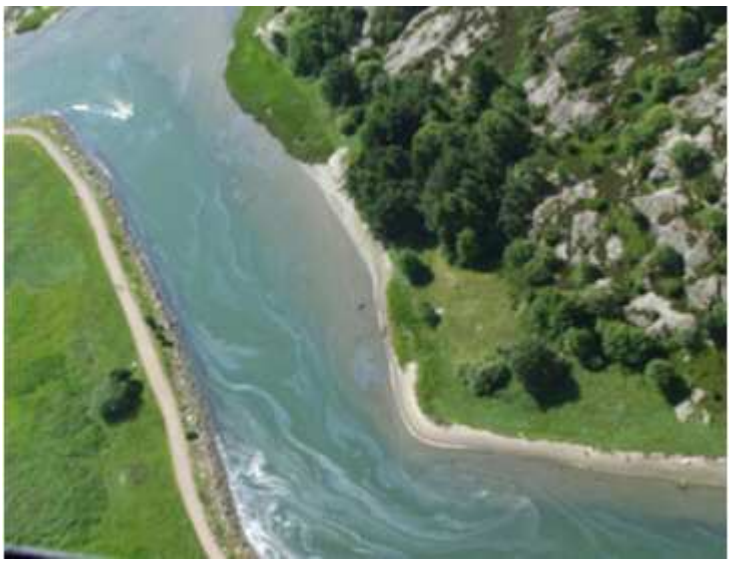
- ✓ The sewer under the pipe rack in the oil terminal has been connected to the harbour oil contaminated drainage water system and is no longer connected to the rain water drainage system.
- ✓ Oil alarms have been installed in the rain water drainage basins. In each basin there is now one oil alarm located at the surface and one oil alarm located in the bottom of the basin.
- ✓ Installation of oil alarm in the rain water drainage system at each oil terminal has been started.
- ✓ Installation of shut off valve of the rain water system at each oil terminal has been started.

The status of the storage tank bunds in the harbour is discussed and there will be improvements in the future.

LESSONS LEARNT

Lessons learnt from this accident include:

- ✓ The human factor has to be considered during design of process systems, operational procedures and check systems. There is always a possibility that routines will not be followed.
- ✓ The handling of heavy oil products in oil harbours has to be considered in safety reviews. Adjustments of system designs and operational procedures may be necessary for a safe handling of heavy oils.
- ✓ The characteristics of the heavy oil products have to be communicated to all persons involved.
- ✓ Safety awareness, frequent training of emergency plans and operational trainings are very important to avoid this kind of accidents.



Environmental consequences of the spill of heavy fuel oil in the oil harbour.

Photos: Stefan Larsson, West Water enterprise.