Investigation report

B 3/2000 M

M/T CRYSTAL RUBINO, environmental accident during loading, Port of Hamina, July 20, 2000

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SUMMARY

On 20 July 2000 the Italian chemical tanker CRYSTAL RUBINO was loading Nonyl Phenol Ethoxylate at berth no. 2 in the port of Hamina. At 1300 the chief officer, who was in charge of supervising the loading, was relieved by the second officer. The second officer had neither the experience nor the qualifications to act as an independent duty officer during cargo loading operations. At 1610 a seaman on deck noticed that the cargo was overflowing from no. 1 port tank ullage hatch. The cargo spilled from the deck to the port side drainage tank at the rear of the deck area and then on through an open drainage tank valve onto the pier and into the sea. Foam was produced in the harbour basin and dead fish rose to the surface.

The main cause of this accident was inadequate supervision during the loading, which was supported by the open ullage hatch and the open drainage tank valve.

The high level alarms (98% full) of the tanks had not been tested before the start of loading. Prior to the loading, the ship/shore safety checklist had been ticked by the chief officer without the relevant items being physically checked.

INDEX

1 GENERAL DESCRIPTION AND INVESTIGATION OF THE ACCIDENT

1.1 The vessel

1.1.1 General data

Name of ship	mt CRYSTAL RUBINO
Type	Chemical tanker, International Maritime Organisation (IMO) type II
Identification	ICCR
Registration	Savona R.I.01
IMO code	9010917
Nationality	Italian
Year of construction	1992
Length max.	124,86 m
Width	17,22 m
Draught	7,10 m summer
Gross	5045
Net	2469
Speed	13 knots
Machine power	4080 kW
Home port	Savona, Italy

Figure 1 The CRYSTAL RUBINO in the evening of the day of the accident

1.1.2 Vessel registration documents

After the accident an inspector from the inspection office of the navigation district of the Gulf of Finland examined the vessel's documentation. According to his findings, the documentation complied with official requirements and the vessel was judged to be seaworthy.

1.1.3 ISO 9002 quality system

The CRYSTAL RUBINO is reported to have a quality system which is in accordance with the ISO 9002 quality standard.

1.1.4 Crew and traffic restrictions

The vessel had a crew of 20. According to the crew certificate this number is sufficient. The two female waitresses listed on the crew roll were apparently on board as passengers.

1.1.5 Loading equipment and method

On the day of the accident, a chemical named nonyl phenol ethoxylate was loaded into the CRYSTAL RUBINO using the pump and pipeline of Kaukomarkkinat Oy. The trade name of the compound is 'Neonol'. The hose connecting the pipeline to the vessel's loading pipes was the property of Kaukomarkkinat Oy. The investigators did not detect any faults in the equipment used in the port.

It was agreed that communication between the ship and the shore would be by shouting. A button for stopping the pump and a valve for shutting the pipeline are fixed at the end of the pipeline on the pier.

Figure 2 The loading hose, attachment on the pier, main valve and emergency stop button. Note incomplete attachment of the flange.

1.1.6 About tanker operation

The vessel is normally owned by a company or other legal entity. The responsibility for its technical maintenance and manning can be transferred to a third party by agreement.

There are companies that own ships but do not wish to maintain them so they lease the vessel to someone wishing to exploit her commercially. In such cases it is usual to transfer the responsibility for the maintenance and manning to the charterer. This kind of activity is known as bareboat chartering.

The owner of the vessel can charter out the vessel but retain the responsibility for her technical management and manning. This activity is known as time chartering. The time charterer uses the vessel commercially for the business activity of the company by transporting cargo on her. This kind of activity applied to the CRYSTAL RUBINO where the time charterer was Crystal Pool, Helsinki.

In order to charter a vessel she must be approved by the charterer. The largest oil and chemical companies (Exxon Mobil, BP Amoco, Shell, etc.) have their own vetting services which inspect vessels for potential charter and vessels that have already been chartered. Such inspections are very thorough and cover all the vessel's certificates, the classification documents, the condition of the vessel, etc. Some of the smaller charterers without their own vetting departments have adopted a practice whereby they require approval by some of the larger oil/chemical companies before agreeing to charter a vessel. The companies belonging to the Ship Inspection Reporting (SIRE) system of the Oil Companies International Marine Forum (OCIMF) utilise this system. SIRE is a database to which an oil company vetting a ship sends its report on the ship, including any possible deficiencies. The owner or operator of the ship has two weeks to react to the report and to any eventual deficiencies mentioned in it.

The oil companies participating in the SIRE system can utilise the reports in this database for internal purposes, i.e. they may approve a vessel based on a report produced by another company. There has been discussion within the OCIMF about letting authorities in Port States to have access to this database, but the issue remains open.

Approval is also required if the oil company performs in 'the chain' as the shipper of cargo, as the operator of a loading/unloading terminal, or as the receiver of cargo.

The Chemical Distribution Institute (CDI) inspects chemical ships and maintains a register like SIRE. The largest chemical corporations – such as Exxon Chemicals, BP Chemicals, ARCO Chemicals, etc. – belong to the CDI.

Usually chemical ships carry approvals from both oil and chemical companies so that they can transport oil products if chemical cargoes are not available. The approvals are valid for 12–24 months depending on the company and the age of the vessel, provided nothing negative happens to the vessel and/or her condition during this period.

Not all charterers approve old vessels. The classification societies have introduced various classifications for the vessels: for instance, the Condition Assessment Program (CAP) classification. In this program special attention is paid to the structural condition of the vessel and its approval for entry into this category is based on this. The system for awarding points varies from one classification society to another but the basic principle is the same. It is even possible to get approval for an older vessel for chartering if she is in good condition.

1.1.7 About ISM code (International Maritime Safety Management Code)

The following is a description of those parts of the ISM code which apply to the case of the CRYSTAL RUBINO.

The purpose of the code is to provide an international standard for the safe management and use of vessels and for environmental protection. Since no two identical shipping companies or shipmasters exist, and since the vessels operate in a wide area in various conditions, the code is based on general safety management principles.

The cornerstone of good safety management is the commitment of corporate directors to operational practices which emphasise safety and environmental protection. In these matters the commitment, competence, attitudes and motivation of the individuals at all levels determine the final outcome. The objectives of the code are to ensure safety at sea, prevent injury to persons or loss of life and to prevent damage to the environment or to property.

The aims of corporate safety management should include:

- safe procedures for operation of the vessel and for ensuring a safe working environment;
- presentation of precautionary measures for all recognisable hazard situations;
- continuous improvement of safety management skills of ship and shore personnel, including preparation for emergencies relating to safety and environmental protection.

The safety management system should ensure:

- compliance with mandatory rules and regulations;
- consideration of applicable codes, directions and standards of the organisation (IMO), the vessel-flagging states, the classification societies and the seafaring organisations.

(ISM code 4). The responsibilities of the person named by the company or the operator (designated person ashore) include the monitoring of safety and environmental issues around the operation of all vessels and ensuring that sufficient resources and shore support are used as required.

(ISM code 5). The responsibilities of the master include restructuring of the safety management system and reporting of the deficiencies in it to the directors ashore (ISM code 9.1). The safety management system should include methods for verifying that the deficiencies and hazardous situations are reported to the company and investigated and analysed with the aim of improving safety and environmental protection.

(ISM code 5). The company should ensure that the master is fully informed of the safety management system and that (ISM code 6) the vessel is manned with competent certified seafarers according to national and international regulations and that the persons assigned to new tasks in safety and environmental protection are properly trained for these tasks and acquire a sufficient understanding of the applicable rules, regulations, codes and instructions.

(ISM code 10.3) The company should verify the procedures in the safety management system for identifying the equipment and technical systems where sudden faults may result in hazardous situations and present the special measures for supporting the reliability of this equipment or these systems. The ISM code applies for example to all tankers.

A shore organisation is audited internally and externally (Registro Italiano Navale classification society, RINA) once a year. A vessel is audited internally once a year and externally (RINA) every 2½ years. ISM certificates are valid for five years.

1.2 Port of Hamina

At the time of the accident the Hamina Port Organisation, which is a municipal company, was operating the port. At the beginning of 2001 the port was changed into a public limited company with the name of Haminan Satama (Port of Hamina).

The company provides the basic infrastructure within the port for ship traffic, as well as providing other services for vessels such as their mooring and casting off and their waste and water management. In the general cargo sector the port is a partner with Hamina Multimodal Terminal and they sell crane services to stevedoring companies.

The port owns most of the land in the port, including the piers. It is the landlord for the companies that operate in the port. As a municipal institution the port organisation acts as both the port authority and the keeper of public order. The port maintains the piers. The port authority issued its Operational Guidelines for the Hamina Oil Port in Finnish, Swedish and English on 8 December 1980.

The terminal operators are responsible for the maintenance of the cargo handling equipment on the piers and they also take care of cargo handling. Kaukomarkkinat Oy is one of these operators.

1.2.1 Chemical port in general

The port of Hamina houses about 500,000 m^3 of tanks used for storing liquid chemicals, fuels and liquid gases for several different companies. Most of these storage tanks are located at the south end of the port where the piers are situated. There are four piers in the Hamina chemical port:

Pier 1 – length 35 metres, maximum vessel draught 9.0 metres.

Pier 2 – length 72 metres, maximum vessel draught 10.0 metres.

Pier 3 – length 80 metres, maximum vessel draught 10.0 metres.

Gas tanker pier – length 170 metres, maximum vessel draught 9.0 metres.

A total of 310 ships visited the chemical port in 2000 and 1,320 million tons of cargo were handled. The total traffic through the Port of Hamina – chemical port, bulk cargo and general cargo – was 4,618 million tons. There were 1,305 ship visits. The total port traffic decreased by 5.9% in 2000 compared to the previous year. The exports in transit traffic for bulk liquid cargo decreased by 20% during the same period.

Some of the substances loaded in the chemical port are discussed further in Section 2.4.

The port area is not completely fenced and there is no access control as such.

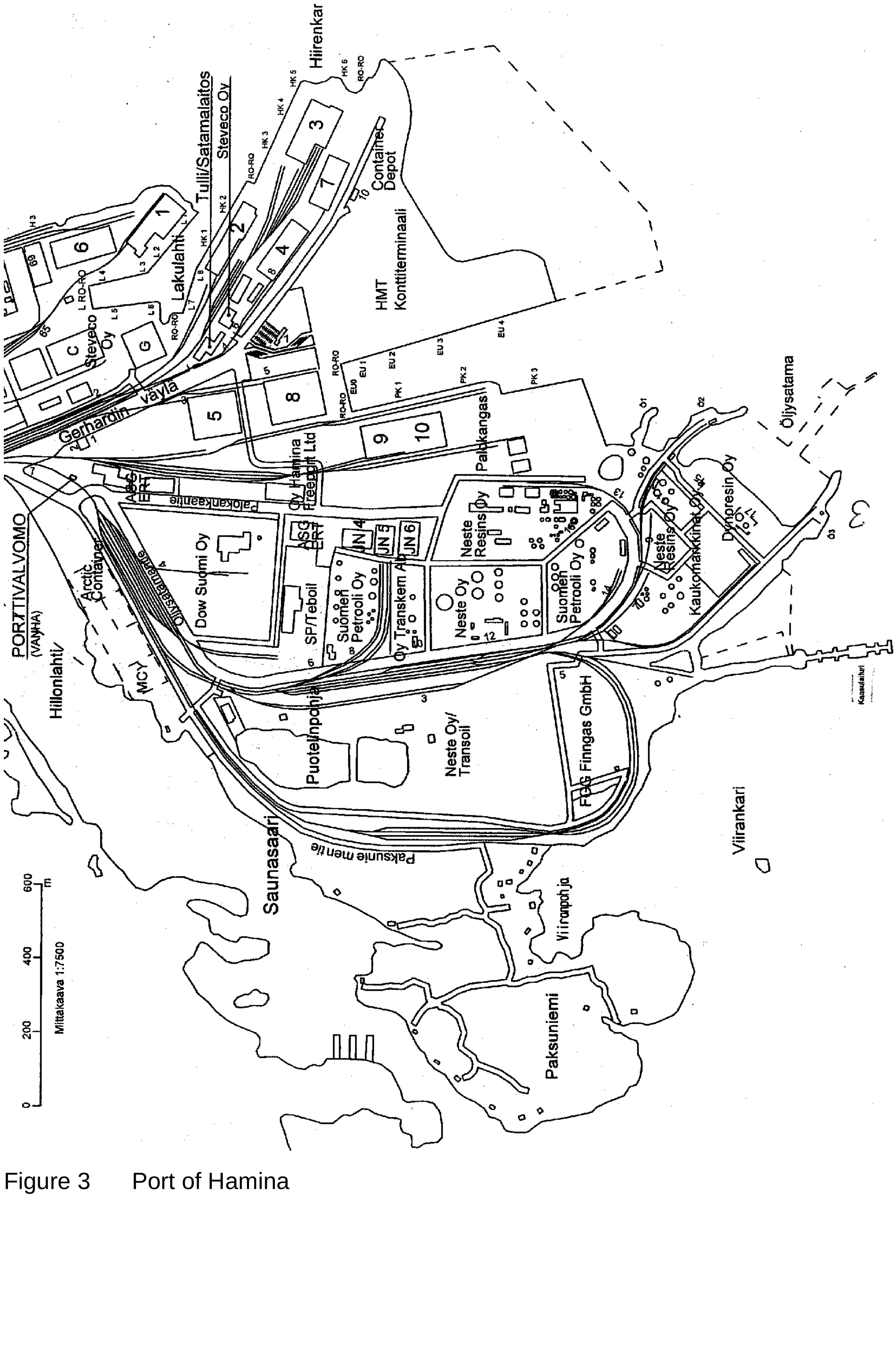


Figure 3 Port of Hamina

1.2.2 Pier 2

There are loading arms on the pier which belong to the Port of Hamina and also pipelines leading from the tank areas of various companies. Among these companies are Kaukomarkkinat Oy, Fortum Oil and Gas, Hamina, Transkem Oy and Suomen Petrooli Oy. A building on the pier houses work and storage facilities and the pier observation room.

There are three drains in the cargo-handling area on Pier 2 (under the arms). The drains conduct rain water and other possible products into a rain well which has an automatic draining system (float pump). Any liquids which might leak from the hose joints will be further conducted into an underground tank. There are two drains at each end of the pier behind the platform outside of the cargo handling area. These drains lead directly into the sea. During the overload of the vessel spilled cargo drained directly into the sea from these two drains.

Figure 4 South end of Pier 2

Figure 5 Upper one-way arrow points at the drain at the actual loading area leading to the pier well. The two-way arrow points at the platform that separates the loading area from the rest of the pier.

1.3 Accident

1.3.1 Weather conditions

The temperature in the afternoon of 20 July 2000 was + 27°C and there was a wind from the south with a speed of 2 m/s. The weather was not in any way to blame for the accident or the resulting level of damage.

1.3.2 Preparation for loading

The inspections that should have been carried out on the vessel's cargo handling equipment before she entered port or handled any cargo were not done. The vessel arrived at Pier 2 in the Hamina Oil Port at 1000 on 20 July 2000. Neither the crew on board nor the staff ashore carried out the safety check inspection before loading commenced. The Hamina Port Organisation stipulates that a safety inspection be carried out and this is also required under the shipping company's safety management system. These safety inspections are based on the International Safety Guide for Oil Tankers & Terminals (ISGOTT), which is the industry standard, and on the recommendation of the IMO. The checklist was ticked on board and the first mate signed it. The shift foreman on shore took one copy of the list and later signed it in the office.

It was agreed that the request to stop the pumps and cease loading would come from the ship. There was no cargo handling plan on board. An outside inspector checked the vessel's tanks at 1030 and the hose was attached at 1108.

1.3.3 Start of loading

Loading commenced on the same day at 1155 with just 30 cm of liquid being loaded into tanks 1P (port side tank number 1) and 2S (starboard tank number 2) for sample taking (1 foot sample). The samples were taken at 1210. The actual loading of these two tanks commenced at 1242, with the first mate supervising. At 1310 the second mate relieved the first mate and he continued to supervise the loading after receiving oral instructions only from the first mate. The first mate did not have time to issue written loading instructions as he was late for his meal.

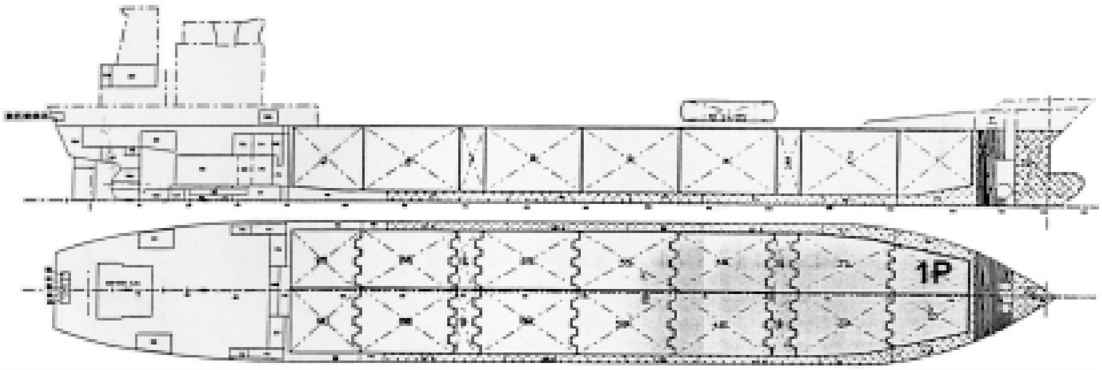


Figure 6 Vessel tank diagram

1.3.4 Agreed communication methods

Shouting was agreed as the method of communication. This agreement was not recorded.

1.3.5 Overfill

On 21 July 2000 the second mate said that when tank 1P gave the alarm at 96% full, he switched the alarm off and prepared to fill the tank to 300 tons by keeping his finger on the valve shut button. When the loading computer indicated that there was 300 tons in the tank, corresponding to 97% of its capacity, he said he had closed both of the valves on tank 1P. Loading continued into tank 2S. Soon after this the deck watch spotted liquid on the deck; he reported this to the second mate on the radiotelephone and shouted 'stop, stop, stop' at the terminal man ashore. The deckhand then squeezed the neck valve of the manifold (end of the vessel pipeline where the loading hose is connected) without shutting it off entirely. The loading was stopped at 1610.

1.3.6 Observations vessel/pier

The seaman on deck was the first person to spot the overfill on board and he took action to stop the loading. His actions were prompt but took place in a disadvantageous order with regard to the extent of the environmental damage. The loading should have been stopped before he reported to the mate. The deckhand did not know that it is possible to shut off the neck valve without causing damage to the shore pipeline. The pump operator in the loading control room heard what was happening and came down onto the pier where he saw liquid spilling onto the deck towards the vessel's stern. He went to shut off the ullage drain valve.

Figure 7 Ullage drain at the stern of the vessel

The shift foreman on the pier was alerted by the shouting 'stop, stop, stop' from on board. At the same time he noticed that liquid was leaking into the sea and onto the pier from a 100 mm diameter hole in the 'well' at the rear end of the ship. The time was 1610. He immediately ran over to the loading pump to do an emergency stop and to close the shore valve. He estimated that this had taken about one minute.

1.4 Emergency procedures

The regional emergency centre received an alarm at 1612 and the fire brigade's chief duty officer at 1615. He arrived on the scene at 1627 and was the first person to arrive, followed by the fire unit at 1631. He observed that liquid was still coming out of the opening at the front of the bridge. This liquid did not rush out in an arc but instead flowed down the ship's side and into the sea. In addition, cooling water was coming out of an engine room drain situated slightly further aft. This water on hitting the sea became foamy. The foreman on the pier gave the “substance safety leaflet” to the fire brigade's chief officer, who then contacted the Finnish Environment Centre for further information about the compound. It became obvious that the substance couldn't be collected from the sea because it sinks to the bottom and dissolves in water. The fire brigade's chief officer also reported the accident to the local maritime inspector. There were about 50–100 dead fish in the water, which could not be collected. The gulls ate most of them. The firemen cleaned the pier where it had been soiled by the liquid. The crew on board used absorbent material to soak up the liquid which remained on deck and then took it on to the pier to a place designated by the firemen. The police arrived and started their own investigation. Representatives from the environmental authority arrived soon after and started to estimate the damage.

At 1653 on 20 July 2000 the Kotka regional alarm centre reported to the duty officer at the Finnish Environment Centre that a chemical had been discharged into the port.

The Finnish Environment Centre has five duty officers and it is their task to prevent environmental damage. Each of the officers is on call 24 hours a day for one week. Their shift change is on Friday mornings.

At 1655 the officer on duty placed a call to the next officer beginning her shift on 21 July and asked her to telephone the fire brigade's chief officer who was at the scene. She made the call and gave him the information on nonyl phenol ethoxylate and its behaviour in sea water: 'The chemical is not very soluble but spreads quickly in a mass of water due to its molecular structure (chemical structure of the compound) producing foam. Nonyl phenol ethoxylate is a non-ionic tenside, in other words a soap-like substance with no ion charge in its structure. The chemical in the sea, nonyl phenol ethoxylate, is a substance that cannot be contained by any currently known method once it is in the water. Therefore, the clean-up of the sea environment (dead fish, birds, mammals, etc.) and the dilution of the chemical (sampling and analyses) must be performed carefully.' On hearing this, the fire brigade's chief officer declared that the fire brigade's duties were concluded.

Figure 8 Foam in the sea after the leak. The substance coming out of the hole at the stern is cooling water for auxiliary machine and not related to the accident.

The Environmental Centre's inspector for southeast Finland telephoned the duty officer who was starting her shift on 21 July to inquire about the properties of the chemical in the sea. He was given the following information: 'Nonyl phenol ethoxylate disperses in water and drifts and dilutes with the currents. The compound disintegrates in sea water as the ethoxylate chain breaks off from the nonyl phenol ethoxylate in approximately 11 to 14 days. After this time, one should be concerned about another toxic chemical, nonyl phenol. The half-life of nonyl phenol in favourable conditions in sea water is about 150 days. Sampling should start as quickly as possible (on Thursday) and enquiries made about the possibility of working overtime in the laboratory in order to speed up the analysis. The weekend is coming and information about the concentration of nonyl phenol ethoxylate in the water should be made available. The water quality in the area can then be checked to see if there is any risk to people using the water for fishing or other recreational uses. A press conference should be organised for Thursday evening. The concentration of nonyl phenol ethoxylate in the water must be monitored up to a distance of at least two kilometres from the place of discharge. The estimate of how much of the chemical leaked into the sea varied between 400 and 10,000 litres. If the necessary information about the concentration of the nonyl phenol ethoxylate is not available by Friday, 21 July (analysis results of the samples) then traffic in the area should be restricted over the weekend.'

Dead fish surfaced immediately after the nonyl phenol ethoxylate discharge. Perch, pikeperch, bream and eel were collected as samples. A flock of gulls 'cleaned' the remainder of the fish floating on the water. The rapid death of the fish is due to the choking effect of the tenside in their gills (ion shock). According to the ecotoxicologist at the Finnish Environment Centre, those birds in the flock that ate dead fish, killed as a result of the discharge, would not be able to produce any young the following spring.

Five hours after the accident, the Southeast Finland Environment Centre arranged for the taking of samples and organised a press conference for 2000 hours.

Another press conference was organised on Friday afternoon, 21 July, where it was decided to set up a safety zone with a radius of 2–3 km from Pier 2. The information was presented in map form and it was proposed that fishing and other recreational uses of the water be restricted because of insufficient analysis results.

The samples taken near Pier 2 and about 30 metres away from the vessel at various depths were analysed in a laboratory in Hamina. The first results were ready at 2200 on 21 July. Based on these results, it could be concluded that the nonyl phenol ethoxylate had dispersed throughout the water in the pier's vicinity. The nonyl phenol ethoxylate concentrations averaged 20 mg/l.

More samples were taken on Monday, 24 July. The results showed that the nonyl phenol ethoxylate concentrations had been diluted to less than 5 mg/l. No nonyl phenol was found in the samples yet. The identification limit for analysis methods based on infrared and gas chromatography is 5 mg/l for nonyl phenol ethoxylate and 1 mg/l for its derivative, nonyl phenol. At a meeting held at 1300 on the same day, a decision was made to dispense with the safety area. A bulletin was subsequently drafted to inform people that there was no longer a need for the safety area or for the restrictions issued on 21 July which limited fishing, swimming and other recreational activities outside the port area. Monitoring of the polluted area continued, however, but the time interval between sampling was increased.

The Finnish Environment Centre proposed using the HPLC method (liquid chromatography) to determine the amount of nonyl phenol (the derivative of nonyl phenol ethoxylate) present in the water samples. A laboratory with the necessary expertise was quickly located.

While waiting for the nonyl phenol ethoxylate to disintegrate in the water, relevant literature was studied. From this, prognoses of dispersion patterns were then drawn up in order to determine the most suitable points for the taking of samples of its derivative, nonyl phenol. Information about currents and winds was reviewed and used as a basis for drawing a map of the sampling plan.

Fresh samples were taken on 2 August. Analysis by the HPLC method showed that the greatest concentrations were situated in Haminanlahti, 10.4 µg/l, and in the north part of the port, 12.5 µg/l. Other samples showed concentrations of less than 4 µg/l.

A decision was made to stop the water sampling because the nonyl phenol concentrations had reduced to a low level; this was because of continuing dilution.

In 1995 some information on background concentrations of nonyl phenol had been published by the Finnish Environment Centre in their information leaflet on nonyl phenol ethoxylates and nonyl phenols.

A few examples of background concentrations of nonyl phenol: Swedish industrial waste water contained 100–4000 µg/l, water leaving a waste water purification plant in Sweden 30–160 µg/l, ground water in Switzerland 2–4 µg/l, the river Rhine in Germany 10 µg/l.

An analysis of the fish (still in the freezer) that had been collected on the day of the accident, 20 July, has not been carried out by the environmental authorities.

As far as is known, there has been no destruction of any sea fauna following the nonyl phenol ethoxylate discharge on 20 July.

1.5 Legislation for ports and terminals

The EC Council Directive 96/82/EY on the control of major accident hazards involving dangerous substances, also known as the *Seveso II* directive, led to the issuing of a Decree on the Industrial Processing of Hazardous Chemicals (59/1999), hereinafter called the *Chemical Decree*, that regulates the activities in oil/chemical terminals and is the basic regulation with regard to safety in the processing of chemicals. This decree was issued to replace the decree that had come into force in 1992. The new decree emphasises the prevention of environmental damage and the implementation of safety management in addition to the identification of other risks. The legislation is controlled by the Safety Technology Authority (TUKES) under the Ministry of Trade and Industry.

The *Act on Occupational Safety* (299/1958) defines the minimum requirements for safe working and activity. In addition, the *Council of State Decision on the Rules and Regulations to be Observed in the Loading and Unloading of Vessels* (915/1985) sets certain safety requirements for the operation of oil terminals, although the decision deals more with piece goods ports. The occupational health legislation in the area is controlled by the Occupational Safety and Health Inspectorate of Kymi.

The *Council of State Decision on the Control of Major Accident Hazards for Employees* (922/1999) defines duties similar to those in the Chemical Decree. In addition, the decision stipulates that the hazards relating to the safety and health of workers shall be addressed as stipulated in the occupational safety regulations.

The *Ministry of the Interior Decision* (SM 1999-00636/Tu-311) on provision for chemical accidents sets its own requirements concerning rescue plans. The Kotka Rescue Centre is in charge of the control of this piece of legislation.

The *Rules and Regulations for the Port of Hamina* and *The Port of Hamina Ordinance* place some requirements on the operators in the port. In addition, the *Operational Guidelines for the Hamina Oil Port* include more detailed stipulations on safe operation.

The Maritime Act and the Safety of Life at Sea (*SOLAS)* and Marine International Pollution (*MARPOL)* conventions*.* The maritime authorities control the seaworthiness and fitness of foreign ships based on the Maritime Act and on the SOLAS Convention. The control of discharges and, for example, the secondary emptying capacity of the cargo handling equipment, is based on the MARPOL Convention. This control is a part of the European Port State Control activity. The maritime authorities do not inspect loading and unloading operations.

The IMO Recommendation on the Safe Transport, Handling and Storage of Hazardous Substances in Port Areas, Assembly Resolution A.716(17), contains a requirement whereby the master of the vessel and the port operator shall, prior to loading or unloading hazardous bulk cargo in liquid form:

1. agree in writing about the cargo handling methods,

2. tick and sign the safety checklist,

3. agree in writing about emergency measures.

A model of the safety checklist is annexed to this IMO recommendation.

Ship/shore safety checklist

Ship's Name ____________ Port ____________

Berth ____________ Time of arrival ____________

Date of arrival ____________

Part A

Bulk-Liquids-General

	Bulk-Liquids-General	Ship	Terminal	Code	Remarks
a1	Is the ship securely moored?				
a2	Are emergency towing wires correctly positioned?				
a3	Is there safe access between ship and shore?				
a4	Is the ship ready to move under its own power?			P	
a5	Is there an effective deck watch in attendance on board and adequate supervision on the terminal and on the ship?				
a6	Is the agreed ship/shore communication system operative?			A	
a7	Have the procedures for cargo, bunker and ballast handling been agreed?			A	
a8	Has the emergency shut down procedure been agreed?			A	
a9	Are fire hoses and fire fighting equipment on board and ashore positioned and ready for immediate use?				
a10	Are cargo and bunker hoses/arms in good condition and properly rigged and, where appropriate, certificates checked?				
a11	Are scuppers effectively plugged and drip trays in position, both on board and ashore?				
a12	Are unused cargo and bunker connections including the stern discharge line, if fitted, blanked?				
a13	Are sea and overboard discharge valves, when not in use, closed and lashed?				
a14	Are all cargo and bunker tank lids closed?				
a15	Is the agreed tank venting system being used?			A	
a16	Are hand torches of an approved type?				
a17	Are portable VHF/UHF transceivers of an approved type?				
a18	Are the ship's main radio transmitter aerials earthed and radars switched off?				
a19	Are electric cables to portable electrical equipment disconnected from power?				
a20	Are all external doors and ports in the amidships accommodation closed?				
a21	Are all external doors and ports in the after accommodation leading onto or overlooking the tank deck closed?				
a22	Are air conditioning intakes which may permit the entry of cargo vapours closed?				
a23	Are window-type air conditioning units disconnected?				
a24	Are smoking requirements being observed?				
a25	Are the requirements for the use of galley and other cooking appliances being observed?				
a26	Are naked light requirements being observed?				
a27	Is there provision for an emergency escape possibility?				
a28	Are sufficient personnel on board and ashore to deal with an emergency?				
a29	Are adequate insulating means in place in the ship/shore connection?				
a30	Have measures been taken to ensure sufficient pumproom ventilation?				

Example of ship/shore safety checklist.

Tank cleaning activities including crude oil washing	Ship		Ship	Shore
Are tank cleaning operations planned during the ship's stay alongside the shore installation?	☐ yes ☐ no	If so have the competent port authority and terminal been informed?	☐ yes ☐ no	☐ yes ☐ no

Declaration

We have checked, where appropriate jointly, the items on this checklist, and have satisfied ourselves that the entries we have made are correct to the best of our knowledge and arrangements have been made to carry out repetitive checks as necessary.

For ship
Name ______ Rank ______ Signature ______ Time ______

Date ______

For terminal
Name ______ Position ______ Signature ______

Repetitive checks (to be recorded by each party on his own copy of the checklist).

Time ______

Signature ______

Example of ship/shore safety checklist, signature section.

1.6 Other safety instructions

ISGOTT

The International Safety Guide for Oil Tankers & Terminals (ISGOTT) is a safety instruction by the OCIMF (Oil Companies International Marine Forum) for ships and terminals. Absolute compliance with this instruction is a basic requirement for operation in terminals controlled by the large oil and chemical companies (Exxon Mobil, Chevron, Shell, BP Amoco, Statoil etc.) and for the ships under their charter. The ISGOTT guidelines can be considered as the operational standard for the industry.

The guidelines and recommendations issued by ISGOTT for practical operations have the nature of directives. Unless the companies commit themselves to observing these, they have no chance of operating in the market. One important guideline is the ship/shore safety checklist for the start and end procedure of the loading/unloading. The industry has thus created an operational standard that the IMO has included in its own recommendations. See Section 1.5. above.

Quality systems

The following subsections should be identified when describing quality or operational systems.

The quality or operational systems are based on *standards*. Standards are operational models for repeated events. Standards are mainly used for guaranteeing compatibility, safety and operational quality. ISO 9001:2000, ISO 14001 and BS 8800 and the safety management code (ISM code) in navigation are examples of standards.

Auditing of a quality or operational system is a systematic, independent and documented process. The auditing evidence acquired thereby is objectively evaluated for determining the extent to which the agreed auditing criteria have been met.

Certification (verification) of a quality or operational system is a procedure whereby a third party issues written verification of the product, method or service complying with the defined requirements.

The company can also observe the requirements of a quality or operational standard without having been certified by an outside company performing auditing and certification. In Finland, the companies performing auditing and certification include SFS-Sertifiointi Oy, DNV Certification Oy/Ab, Lloyds Register Quality Assurance Ltd and Bureau Veritas Quality International.

The most common quality and operational systems share the following requirements:

- The company must have a 'Quality Manual' in which the company describes its own activities according to the requirements of the chosen standard.
- The company must have a management system for handling documents and quality files.
- The responsibilities and authorisations of personnel should be described in detail.
- The company must have procedures for controlling exceptional products or methods.
- The quality manual must contain a description of the auditing methods of the company.
- The quality manual must contain a description of corrective and preventive measures.

1.7 Nonyl phenol ethoxylate

Formula C_9H_{19} - Ar - O - $(CH_2$ - CH_2 -O$)_{10}$ -H where Ar is an aryl group (aromatic ring).

The UN code for nonyl phenol ethoxylate is 3082, the transport category is 9 and the hazard code 90. MARPOL class B. The substance is used, for example, as an ingredient in the manufacture of various hygiene products.

Nonyl phenol ethoxylate (abbreviated NFE), trade name neonol, is a clear, viscous fluid with a density of 1.06 g/cm^3, a melting point of +6°C and a solubility of 6 mg/l in water. The substance can cause serious eye damage. In addition, skin contact with the chemical should be avoided because the substance is toxic. Discharges into the environment should be avoided. The substance is not to be discharged into the sewage system.

Nonyl phenol ethoxylate is toxic to waterlife and can cause long-term damage to a water ecosystem.

The toxicity rate to fish, LC_{50} - rate 5 mg/l (50% of the fish die during exposure).

Nonyl phenol ethoxylate is not easily dissolved in water but disperses in it as molecules. The substance breaks down into nonyl phenol in 11.8 to 14 days in seawater.

Nonyl phenol ethoxylate is destroyed by burning in a waste-processing plant.

Nonyl phenol

Formula C_9H_{19} - Ar - OH.

The solubility of nonyl phenol (abbreviation NF) in water is 1 mg/l, and its density 0.97 g/cm^3. The substance is corrosive and highly toxic to the environment.

The toxicity of nonyl phenol can be illustrated with the LC_{50} values during 96 hours of exposure: rainbow trout 0.23 mg/l, char 0.15 mg/l and trout 2.7 mg/l.

Nonyl phenol is a lipophilic substance. It can travel in the food chain and accumulate in fat tissue.

The half-life of nonyl phenol in seawater is about 150 days.

The concentrations in the samples collected from the Hamina water area were in the range of µg/l (1 µg/l = 0.001 mg/l).

Nonyl phenol has been found to have hormonal effects. Although structurally nonyl phenol deviates considerably from 17β-oestradiol, or 'female hormone', nonyl phenol acts like oestrogens.

Hormones, the nervous system and the immune system all affect the functions of humans and animals by regulating their metabolism, reproduction and growth. Hormones are the message carriers between the hypothalamus, thyroid gland and reproductive glands. The hormone system is sensitive to external influence. The disorders related to the reproductive and thyroid glands are well known.

Nonyl phenol has been found to work like oestrogens in male fish, male birds, male hares and male rats, resulting in considerably weakened or ceased production of milt/sperm.

Other chemicals which affect hormone function include PCB compounds, DDT, dibutyl phtalate, tributyl tin oxide as well as several industrial chemicals and pesticides that can accumulate in animals and humans over the course of years from underlying concentrations present in the environment.

1.8 Accident investigation

1.8.1 Appointment of the board of investigators

The duty officer of the Accident Investigation Board was notified of the accident by the police at 2030. A representative of the Accident Investigation Board was dispatched to the scene the same evening and he visited the ship the next day, too. It was decided to postpone the setting-up of a proper investigation board until the preliminary investigation launched by the police could provide some kind of overall picture of the accident and the factors leading up to it. On 11 August 2000 the Accident Investigation Board appointed an investigation board for a major accident hazard. Risto **Repo,** Accident Investigator, Sea Captain, of the Accident Investigation Board was appointed as chairman of the board. Juha **Sjölund** and Ilkka **Pelli**, Sea Captains, were appointed as members of the board.

The board of investigators called Chief Engineers Hannu **Alen** and Harri **Halme** of the Ministry of Social Affairs and Health, Department of Occupational safety to serve as experts in the study of the safety systems ashore.

The police launched a preliminary investigation shortly after the accident under the heading ’Serious Damage to the Environment’.

Senior Inspector Tuula **Kuusela** of the Finnish Environment Centre assisted the board by providing information on the properties of nonyl phenol ethoxylate.

1.8.2 Inspections made during the accident investigation

The work of the investigation board was based on the following: a study of the loading work on board the vessel and the operation of Kaukomarkkinat Oy in the port, a study of the port and the interviews conducted by the police, and a study of the experts’ reports and of the interviews of the parties involved.

In its own review, the board studied the contents of documents related to the safety management system of the ship. They also interviewed the crew.

The experts on the board provided a written report ’Evaluation of the level of safety activity in the chemical port of Hamina’.

Representatives of the board visited the ports of Rauma and Rotterdam to compare the safety principles and practices of their port operators.

1.8.3 Comments on the recommendations

The draft of the accident investigation report was forwarded for comments as stipulated in paragraph 24 of the Decree on Accident Investigations (79/97) to the Ministry of Transport and Communications, Ministry of Trade and Industry, Ministry of the Interior, Ministry of the Environment, Department of Occupational safety at the Ministry of Social

Affairs and Health, the Finnish Maritime Administration and to Port of Hamina Ltd. The draft of the accident investigation report was also forwarded to Kaukomarkkinat Oy, Crystal Pool and the Finnish legal advisor of the CRYSTAL RUBINO for eventual commentary.

The comments are appended to this investigation report.

2 ANALYSIS

2.1 Safety management procedures on the CRYSTAL RUBINO

The safety management system on the CRYSTAL RUBINO has been audited and a Safety Management Certificate was issued on 30 May 1997. The system complies with the ISM code. The Document of Compliance for the shipping company was issued on 25 January 2000 and it is valid until 23 January 2005. The classification society RINA performed the auditing and certification under authorisation from the flagging state (Italy). Based on the documentation, internal audits have been carried out as required.

Review on board

The following observations were made during the review of the Safety Management System of the CRYSTAL RUBINO, set up according to the requirements of the international safety management regulations (ISM code). The review was conducted in Kotka on 14 November 2000.

The *responsible operator* of the ship is FINBETA S.A. of Savona, Italy. This company is also the registered owner of the vessel.

The Safety Management Certificate for the vessel was issued for the period from 30 May 1997 until the end of February 2001. The stipulated intermediate audit has been carried out according to the specifications in IMO resolution A.788(19).

FINBETA S.A, who is the responsible operator of the ship, has a safety management system suited to the operative management of chemical vessels, according to the Document of Compliance issued on 25 January 2000 (DOC 01/2000 RINA).

No major discrepancies between the practices of FINBETA S.A. created for achieving the safety management objectives stated in the safety and environment policy of the company and the practices observed on the vessel were discovered, excepting some items discussed later (e.g. Certificates of Competency, safety checklists, testing of alarms before loading, the reporting and analysis of irregularities).

The crew’s competency certificates were in order with the exception of a so-called additional competence book for chemical container ships’ personnel. There was no documentation on board stating clearly that these supplementary certificates had been issued by the Italian Maritime Administration, as stipulated in STCW-95.

The Technical Director (technical matters) and the Managing Director (operational matters) of the company acted as 'Designated Persons Ashore' as stipulated in the ISM code.

According to the master, FINBETA S.A., who is responsible for the operations, provides adequate onshore support and resources whenever needed.

The area of responsibility of the master stated in the safety management documents of the vessel complied with the regulations of the ISM code. For the last three years no reports could be found which pointed either to the existence of clear and uniform practices in the renewal of the safety management system or in the reporting of irregularities to the directors ashore.

Three different nationalities made up the vessel's crew: Italian, Spanish and Polish. In this context it should be mentioned that the people interviewed during the review on 14 November 2000 had not been working on the ship on 20 July 2000. The crew at that time consisted of Italians and Poles.

The official working language on board is English. It is, however, natural for the Italian majority of the crew to address each other in Italian. The safety management manuals are in English, however.

A training system exists for new people joining the ship and for people transferred to other duties on the ship. This system better covers the training needs of the officers than of the crew.

The practices relating to the safe operation of the vessel and the protection of the environment are described in detail in the safety management manuals. During the review, it was observed from reports and completed checklists that these were fairly well followed. With regard to activities on the bridge, however, it was discovered that prior to the arrival in Kotka on 14 November, no markings to record the vessel's position had been entered on the chart for the previous 40 minutes. Likewise, the three last route points of the observed passage plan were without entries noting the actual times of the passage. The reason given for this was that the master was alone on the bridge with the pilot and therefore had had no time to make the necessary entries. The safety management manuals suggest, however, that the first mate be on the bridge with the master when steering into port. The explanation given by the master for this non-adherence to the manual was that he wanted to let the first mate get some rest, as he would be needed during the loading.

The Cargo Handling Manual dated 1 October 1996 describes cargo handling and its related activities comprehensively. Deficiencies in the execution of one, or a few key tasks, however, contributed to the overfill on 20 July 2000. Particularly, negligence in the proper shutting of hatches and drains on deck aggravated the harmful consequences of the overfill to the environment.

The reporting and analysis of deficiences, accidents and hazards both within the company itself and on the ships under its management was not frequent or detailed enough. The number of documents was few.

An example of this is the overfill of 20 July 2000. The cause of it, and the resulting re-evaluation of the operational practices resulting from it, are not clear although the incident has been discussed both in the company and on the ship. Various explanations ranging from a hair crack in the valve to different technical faults have been offered.

Nevertheless, as a result of the accident, the shipping company has since fired the mate who was supervising the loading.

Use is made of the 'Infoship' information control system for the equipment planning and advanced servicing of the CRYSTAL RUBINO. The company monitors the ship's technical status in real time using a so-called online method. The on-board system holds the details of the checks carried out at set intervals, of any malfunctions detected and of the corrective action taken. The ship's technical staff make the entries into the system. As a result, the human factor is not excluded from the system.

The vessel's safety management manual was dated 18 January 1994 and the latest update made to it before the accident was dated 10 May1999. The document after the accident was dated 22 August 2000.

Other manuals linked to the safety management system were studied, in part, where applicable, during the review of the ship.

The annual internal audits of the company were conducted by the representative of the company and/or by auditors of RINA as described in the safety management manuals. The dates of the last three internal audits were 26 January 1999, 6 January 2000 and 20 September 2000.

The two Port State Checks (PSC) before the review were made in Harwich, England on 11 November 1999 and, after the accident, in Hamina, Finland on 24 July 2000.

To summarise the review it can be stated that the safety management system applied on board the ship fulfils the requirements of the ISM code. However, attention should be paid to the reporting and analysis of irregularities, accidents and hazards, the competency of the staff and careful observation of the operational practices recorded by the company.

2.2 Port of Hamina: operational guidelines and regulations

The following analysis (sections 2.2.1–2.2.8) of the level of safety activity in the Port of Hamina and the Hamina terminal of Kaukomarkkinat Oy is based mainly on the report of the experts on the board.

2.2.1 Port operator

With regard to safety, the operation can be considered to be on a level consistent with the regulations and guidelines. The port organisation self-regulates the safety level of the port operators by issuing directives, but the organisation itself has not set its own safety requirements in the Port Ordinance. The Port Ordinance states that the duties of the authorities controlling the Port Ordinance are defined in the Port Rules and Regulations. The Rules and Regulations of the Port Organisation list the duties of the Port Board, Port Director, Harbour Master and the Head of Construction but responsibilities or duties relating to safety are omitted entirely from the Rules and Regulations, as are the control duties. The Port Ordinance and the Operational Guidelines for the Hamina Oil Port are old, dating from 1980 and 1987, but for the most part their contents are still relevant.

The method of ensuring that operational instructions are brought to the attention of the ship, and whose responsibility this is, have remained unclear, however. Three different answers were received from the port personnel during their interviews as to whose responsibility it is to inform the ship of the rules and regulations to be observed in the oil port: the port organisation, the terminal operator and the broker. It is likely that ships whose crews were fully ignorant of the oil terminal's operational guidelines have, in the past, visited the port.

According to the Chemical Decree (59/1999), extensive processing of hazardous chemicals is an activity requiring a licence. Depending on the amounts involved, the operators in the port are required to have either a safety review or a safety management system. However, this is not required of the port organisation (TUKES). The Port of Hamina is classified as a storage area for flammable substances and it has been separately licensed (TUKES). The port organisation is the licence holder for the flammable substances storage area.

The Act on Occupational Safety (299/58 with later amendments) requires an employer to have a work protection action programme which covers all work-related development needs and anything which is related to the working environment. The city of Hamina (the employer) has a general programme covering this area, including also the port organisation. With this arrangement, the specific needs of the port organisation may not be adequately taken into account.

2.2.2 The Port of Hamina's operations as an authority and supervisor

The port organisation should be responsible for seeing that the operators in the port observe the rules, port ordinance and oil terminal guidelines drafted by the port organisation. The port ordinance stipulates that the port ordinance shall be observed within the port area. There is no mention of supervision. The oil terminal guidelines stipulate that they are applicable to the operations in the Hamina oil port. There is no mention of supervision.

The port organisation has set no criteria for the type of ships that can come into the port for the loading or unloading of their cargo.

The official role of the port can be considered minor. Their supervision is mainly concerned with the general appearance of the port ('how things are looking'), control of the overall order and tidiness but not supervision of the operators. The port organisation's function is viewed as being that of a provider of operational flexibility and of a provider of facilities for the port operation. The port organisation tries to interfere as little as possible with the terminal operators' business of loading and unloading ships. They have wished to view their role as that of a background player rather than of an active participant. For example, the port officials have never inspected a ship at berth even though the Port Ordinance gives them the authority to do so.

Kaukkomarkkinat Oy was not familiar with either the Port Ordinance or the Operational Guidelines for the Oil Port prior to the CRYSTAL RUBINO accident. These guidelines cannot have played a major role in the present situation. When the guidelines were approved, they would certainly have been distributed to the companies operating in the port but over the years they have been forgotten.

The port organisation itself estimated that there are clear differences between the operators with regard to operational safety. Neither the port organisation nor the rescue services have received (or requested) quarterly reports from all the operators as stipulated in the operational guidelines.

2.2.3 Safety management

The Port Board has not set any safety objectives (operational or occupational).

The port organisation has not systematically analysed the safety needs, has made no risk assessment and has had no aims with regard to safety activity. Their activity has mainly centred on reacting to irregularities, whereas some of the actual ideas for developing safety may have originated from the city authorities. A study thesis completed in the summer of 2000 discussed the port organisation’s work-safety development needs.

The safety checklist is seen as the main provider of safety control during loading and unloading. The port organisation expects the list to be filled out jointly by the person responsible for the loading/unloading in the terminal and by the first mate (ship’s officer). It is the port organisation’s view that if the terminal operator is responsible for filling out the list, then the safety requirements are fulfilled. The terminal operator on the other hand is of the opinion that the vessel, and not itself, is responsible for those items on the list concerning safety which apply to the vessel. The fulfilment of the safety requirements ends with the list, and its eventual ticking, instead of on a secure and reliable verification of the items on the list. The operators have created their own versions of the checklist. The port had previously required that it be supplied with a copy of the checklist for each loading/unloading. This practice was later abolished and its abolition may have given the impression that the list was not important.

Safety activity and occupational safety are reactive, not proactive. Any detected shortcomings are rectified.

With regard to safety control, the organisation itself does not do any monitoring or follow-up of its own activities. A deviation report has been in use for a few years but the number of such reports has been few. The port organisation and the companies operating in the port share their security services. These are contracted from an outside service provider (Securitas).

The operation is fairly settled with the tasks and routines remaining the same for the past ten/twenty years.

It is possible that safety management is also a question of know-how. This question has now been addressed with the employment of a safety inspector in the port whose task is to evaluate safety issues and make suggestions for improving and managing safety.

2.2.4 Other observations of the safety operations of the port authority

Work protection action programme and occupational health care action plan

The work protection action programme dates from 1997 and it was drafted for the entire city's personnel. The plan, as such, is versatile but it does not have any effect on the occupational safety in the port. The occupational health care action plan is comprehensive; it lists a variety of health checks for different target groups. Some of the staff are targeted for activities which enhance their ability to work and the plan also includes the use of a work ability index.

Activity of the top directors

As stated above, the safety activity has no aims and the directors do not have a strong role in safety activity management. The development angle concerning safety activity has been weak, at least until the summer of 2000. The needs of staff with regard to safety competence have not been studied. Recruitment of new staff is rare.

Supervision by the foreman

Work (mooring and casting off of vessels) is done by a team and the foreman works with his team. The team receives its tasks independently through PortNet (the service network for ports and navigation). No discussions are held and no documentation is produced on the issues agreed/decided. Directives are put up on the notice board. It could be difficult to form a picture of the supervision carried out by the foremen (representative of the employer) as being that which is stipulated in the Act on Occupational Safety.

Monitoring of the working environment and risk assessment

The working environment is not systematically monitored with regard to the role of the port official in such a way as to include the control and monitoring of the safety of the operations of the companies and ships in the port or of the port regulations and the recording of any shortcomings. No assessment of the occupational safety risks in the working environment with regard to internal occupational safety has been carried out but a study of work safety development needs was completed in the summer of 2000.

Maintenance and acquisitions

Some of the maintenance for the port is supplied by the city and some is commissioned directly from outside. A smooth consideration of safety is not always possible in acquisitions and repairs.

Personal protection

Personal protection is little used: the port supervisors wear personal flotation devices, so called pop-vests, when mooring or casting off vessels; their car has a portable extinguisher; helmets are not worn during the mooring/casting off of vessels except in the HMT operator's area where the use of helmets for all personnel is required. There is a store in the oil terminal for protective gear where the port supervisor can get a breathing mask or protection gear for use against chemicals when needed.

Rescue alertness

The port area is one of the target areas annually inspected by the rescue services. The oil port operators are currently updating the bulletin concerning major accidents which may be hazardous to people living/working in the vicinity. This information is required under the Industrial Chemical Decree.

The Kotka Rescue Centre maintains an external rescue plan and the port organisation and the operators their own internal plans. The fact that safety systems complying to old standards can still be used in the port area was considered problematic. The safety walls for equipment and pool protection have been constructed according to old standards. Only the new terminals comply with the new fire safety standards.

Once a year, joint drills are held with the rescue services either at their request or that of the port organisation. The pier operations have usually remained outside these drills because they have focused their drill practice on a fictitious accident scenario.

The rescue organisation arrangements between the City of Hamina and the municipality of Vehkalahti have caused difficulties. The difficulties have arisen from the fusion of the two organisations. Communication between the port organisation and the combined rescue services has been viewed as somewhat problematic. The Kotka Rescue Centre is now in charge of the management services for the rescue department and things now seem to be in order.

Deficiencies reported in the bulletin: the port organisation has not always been informed as to the reason why personnel from the rescue services, and their equipment, are present in the port area.

There are shortcomings in the way reporting is practised. The rescue services do not get their quarterly reports in the manner stipulated in the directives.

The reports on hazardous substances as stipulated by the Council of State Decision 915/1985 on the rules and regulations to be observed in the loading and unloading of vessels are received by the port organisation and forwarded to the rescue services. On occasion, a container may be hauled by road into the port without the necessary documentation.

The rescue centre has a strong knowledge of chemicals and they know how to use this knowledge to combat chemical accidents. This subject has been especially emphasised.

The rescue services do not employ their own trained chemist so when an accident occurs they make contact, if possible, with one of the following: local experts; the duty officer of the Finnish Environment Centre (SYKE); the shipper, or the recipient of the chemical.

Cooperation between authorities

The port area, and the operations in the port, are controlled by various authorities: the Safety Technology Authority (TUKES) by the authority stipulated in the Industrial Chemical Decree; the Occupational Safety and Health authorities based on the Act on Occupational Safety; the Maritime Administration authorities based on the maritime regulations; the police based on regulations concerning general order; the rescue services based on legislation on fire and rescue activity; the environmental authorities with regard to environmental safety; and the port organisation based on its own ordinance. The City of Hamina is licensed to operate a storage area for flammable substances. (Technical Inspection Centre 1990). Statements from the authorities have been taken into consideration when granting a licence. There is no regular cooperation between the authorities concerning the licensing of the port and no one coordinates the activities of the authorities. The port organisation considers the cooperation between the various authorities to be good. However, it is reported to be difficult to get the police to come to the port area.

Follow-up and monitoring

There is no systematic follow-up or monitoring of activity.

Information and communication

The dissemination of information within the port organisation is scant and disorganised. Breakdowns in communication between shifts may occur.

The systematic use of certain agreed channels for informing other harbour operators, and users of the harbour, about topics agreed were not in any way highlighted in the interviews. Announcements are usually made in the course of normal meetings and operations. The operators have to organise meetings and cooperation to comply with the procedures laid down by law, but this has been done haphazardly.

Communication with the ships was not regarded as a problem but the terminal operator expressed a desire to improve its own ability to communicate with ships' crews.

Safety attitudes and culture

Nothing special surfaced in the interviews. The practices and attitudes of people who have held the same job for a long time are as can be expected. The hiring of a person who focuses on safety issues may bring fresh air to the way of thinking but even this requires commitment from the directors.

2.2.5 Safety operations at Kaukomarkkinat Oy

The organisation has previously been covered by the Industrial Chemical Decree (682/90, amendment 703/1992) with regard to the site of major accident hazards and it has drafted a safety review as stipulated in the decree. The new decree (59/1999) requires also a safety review from the operators. The deadline for this review was 1 February 2001 and the operator had to demonstrate the following:

- adoption of principles for the prevention of major accidents and other accidents and for realising the principles of the safety management system;
- awareness of the risk of major accidents relating to the operator's activity and implementation of the measures necessary for the prevention of such accidents and the limitation of its consequences;
- that it has taken into account sufficient levels of safety and reliability in planning, construction, operation and maintenance;
- existence of an internal rescue plan and the delivery of an external rescue plan taking into account the use of the land surrounding the production facility.

The safety review stipulated in the old Industrial Chemical Decree (1992) has been drafted and approved by TUKES with a few small points demanding attention. The new safety review is currently being written. In the regular reviews stipulated in the present legislation, TUKES has made no mention of any relevant deficiencies in its records.

The Council of State Decision on the Prevention of Major Accident Hazard (922/1999) stipulates that the employer shall attend to the measures necessary for the prevention of a major accident hazard in all activity in the work place on a continuous basis. Special emphasis should be laid for the preparation for major accident hazards caused by repairs, service and modifications. In addition, the employer shall, when drafting these plans, documents and reviews, process the issues related to the safety and health of the employees with the employees or their representatives as expressly stipulated with regard to cooperation in matters related to occupational safety. This process, stipulated in the regulations, had not yet been started.

The Act on Occupational Safety requires, for its part, continuous monitoring of the working environment and identification of hazards. The records from the occupational safety and health inspections include directions for the loading of ships. The records do not include major deficiencies concerning the Act on Occupational Safety. Furthermore, the interviews did not bring anything to light along these lines.

The Port Ordinance and the Operational Guidelines for the Oil Port have remained unfamiliar to the present directors and personnel and were only studied after the accident. It is probable, however, that the persons creating the work and operational practices have known of the directives. The operational practices comply, for the most part, with the Operational Guidelines for the Oil Port. The quarterly reports on the stock status have not been made for the rescue services and the task descriptions of the staff working in the loading, such as the pipe watch, differ from the Operational Guidelines.

2.2.6 Safety management at Kaukomarkkinat Oy

A safety review according to the Industrial Chemical Decree has been carried out in the company. The review charts, for example, the hazards and risks of a major accident. Continuous monitoring and follow-up of the activities in recent years could not be identified in the interviews.

The updating of the safety review as required by the legislation is under way. The terminal director is in charge of the safety reviews and the related cooperation with the relevant authorities. In practice, the operative director takes care of the general activities. It is important in this division of labour that the relevant safety issues brought to light by the review, or by the authorities, are integrated as standard practice into everyday work.

The safety checklist is one method of managing safety but it is viewed in a slightly different way in the terminal than in the port organisation. The completion of the list has been made into a compulsory task required by the bureaucracy before any ship can be loaded. Its relevance to safety has become blurred. In the case of the CRYSTAL RUBINO the list was not processed correctly. The shift foreman and first mate did not sign the list when the check was completed, but instead it was left on board and the foreman signed it ashore later. According to the loading directions, both must sign the list when the check has been completed.

The development of safety in the terminal is reactive by nature, not proactive. No objectives, aside from those deriving from the legislation, have been set for the safety activity.

The working instructions have been jointly formulated and the staff knew how to access them. The description of the operational system is currently being drafted. In this context, it is the intention to update the working instructions and the safety regulations. The working instructions for unloading the ship were missing.

From the point of view of safety management, there is no definition of who makes the decision of aborting or postponing the loading if, for example, the wind conditions or a thunder storm are threatening (as mentioned in the Operational Guidelines for the Oil Port). The decision is noteworthy and requires good, clear directions for its back-up. These do not currently exist.

The operation fulfils the minimum requirements demanded by the set safety procedures. Due to the nature of the study, negative issues may be emphasised.

2.2.7 Other observations of the safety operations of Kaukomarkkinat Oy

Operational plan for work protection

The operational plan for occupational safety dates back to 1996. The plan is general and versatile by nature. Its draft was based on a standard model and it has had, in practice, no effect on the occupational safety activity of the company.

The action for occupational health is drafted with the terminal director for a two-year period. No exposure readings have come to light which exceed the limits.

Activity of the top directors

Safety actions, as were earlier mentioned, do not require additional objectives in order to fulfil the requirements of the legislation. Monitoring and the follow-up of the action in a safety sense is limited and, as such, there is no safety evaluation. An operational policy exists, since the operational manual is currently being updated. However, no general information about this has yet been given to the staff. The development angle regarding safety activity has been weak, at least until last summer. The competency needs of the staff with regard to safety have not been separately charted but issues relating to language skills and communication with the ship were raised in this context. Recruitment of new staff is rare; it is not possible in this review to evaluate the factors which need to be emphasised with regard to recruitment.

Supervision by the foreman

Work is performed by a team and the foreman works with his team. The team receives its tasks via daily instructions drafted by the head of operations and from the meeting held at the shift change. The head of operation supervises the team’s work and the team leader the work of the team members. The team does not identify a representative of the employer for its work as stated in the Act on Occupational Safety.

Monitoring of the working environment and risk assessment

The risks relating to occupational safety in the working environment, and in part the potential environmental risks, have been assessed in connection with the safety review. Among others, the risk of overfill during the loading of a ship has been recognised. The working environment is not systematically monitored from the point of view of internal occupational safety. Neither is it monitored from the point of view of including the monitoring and control of the safe operation of the ships and of compliance with the port directions or the charting of the deficiencies observed in this activity. The safety of the unloading of vehicles and railway cars is monitored in the terminal area. The terminal area is divided into three sections where the shift foremen monitor tidiness and order. The terminal has a method in use for reporting any irregularities.

Maintenance and acquisitions

Maintenance and its related planning are supplied by outsiders. The suppliers are, for the most part, the same friendly established partners who ’know the house rules’. A seamless consideration of safety features is not always possible in acquisitions and repairs. A work permit procedure is used in maintenance whereby the job description, the location, the protection, the security and the need for personal protection are discussed with the contractor. The final inspection of the work is also scheduled at this stage. In addition to his own work the head of maintenance supervises the work performed by outside contractors, mainly from the point of view of results rather than performance.

Personal protection

The use of personal protection varies and the company does not enforce its use: it is ’up to the individual’. There is sufficient personal protection gear, it is available for everyone and its necessity is mentioned in the work instructions and user safety bulletins.

Rescue alertness

The port area is one of the rescue services’ targets for annual inspection.. The oil port operators are currently updating the bulletin concerning major accidents which may be hazardous to people living/working in the vicinity. This information is required by the Industrial Chemical Decree.

The Kotka Rescue Centre maintains an external rescue plan and the port organisation and the operators their own internal plans. Safety systems that comply with old standards can still be used by the operators in the port area.

The fire fighting equipment has developed over the course of time. The location of the fire hydrants has also been determined in connection with other developments. There is a map showing the location of the fire alarms, but not the fire hydrants.

Drills are organised twice a year for practising basic extinguishing procedures and fire equipment handling. The attitudes towards these drills need to be improved as, at present, they are just viewed as a nuisance. Kaukomarkkinat organises drills within its own area but little within the area of the pier.

Cooperation between authorities

The terminal and its operations in the port are controlled by various authorities: Safety Technology Authority (TUKES) by authority stipulated in the Industrial Chemical Decree, and the Occupational Safety and Health Authorities based on the Act on Occupational Safety. The Maritime Administration authorities control the ships’ equipment and its condition, and the competency of their crews based on maritime, and other, regulations concerning ships. The actions of the rescue services are performed with regard to a decision by the Ministry of the Interior, the environmental legislation and the harbour authorities’ own ordinances. In addition, the police monitor law and order.

According to the Chemical Decree, the Safety Technology Authority shall request statements from other authorities when issuing licences to an operator, evaluating its safety review or when granting eventual exceptions. The Safety Technology Authority shall also provide an opportunity for other authorities to participate in the regular inspections.

The role of the port official remains unclear. More information about the supervision of TUKES from within the company is required and there was a request for the Occupational Safety Inspector to show himself more often.

Follow-up and monitoring

There is no organised, documented follow-up and monitoring of activity, whereby compliance with the regulations and the port rules could be verified.

Information and communication

The dispersal of information has noticeably developed in a positive, more open direction. Internal communication takes place in the form of bulletins and regular meeting practices.

Difficulties relating to language skills have been recognised as a problem when communicating with the crews of visiting ships. With regard to safety, good communication with the vessel's mate is important when preparing the vessel for loading, when supervising the loading and especially when completing the loading. There are often crew members on board with whom it is difficult to communicate in English.

Safety attitudes and culture

The interviews produced nothing worthy of special attention. Occupational safety and other safety issues are processed in a positive spirit together with other routines. No disagreements were reported. The handling of chemicals operationally with pipes and pumps leaves no room for negligence. This ensures that the work is done carefully and that any faults are attended to immediately. However, any violations are unlikely to result in disciplinary action, such as neglecting to use personal protection equipment.

2.2.8 Summary of the review of the safety operations

In the evaluation of safety levels it has been shown that there are no aims, and furthermore, no attempts to actively develop target-orientated safety in the port organisation or the terminal. The safety activity is mainly reactive in that it only addresses any detected shortcomings. In principle, the Industrial Chemical Decree directs the terminal to act in a clearly proactive direction in order to prevent accidents from occurring. There is no safety management but instead the work practices have gradually evolved to accommodate the legislation and the port directives. The concept of safety clearly needs to be developed, both in the mind and the workplace.

No overall picture is formed anywhere of the safety of the port. The port organisation and the operators in the port are each responsible for the safety of their own operations and the port organisation also according to its licence as a chemical port. The licensing authority has set down certain common requirements regarding fire safety and security within the port. Each operator is responsible for safety in its own area. The licensing procedure for a chemical port has remained unrelated to the affairs of individual operators. The Port of Hamina's licence dates from the 1980s and has not been renewed since. The port organisation itself does not necessarily receive any information about the operators' licences or about their licensing terms. The common areas controlled by the port form a 'grey zone' where operational practices and responsibilities are not clear.

The authorities control the operations and the set the conditions within their jurisdictions. The rescue services do indeed collect data on safety risks. Initially this happens from the viewpoint of the fire and rescue services such that fire and environmental damage prevention is at all times possible.

The licence for the Port of Rauma (TUKES) allowing it to act as a storage area for hazardous chemicals dates from 1995. Clearly the conditions set down in it are more up to date that those set down in older licences, such as Hamina's.

The role of the city or of the Port Board in the development or the support of safety has remained relatively minor. When the corporate structuring has been completed the safety activity will need to be reorganised. The role of the port authority has to be reconsidered and the safety conditions for those operating within the harbour should also be reviewed again with regard to the cooperation agreement and the operational requirements.

In recent years, the development of the port in Hamina has centred on piece goods. Oil port affairs have received less attention. The growth of container traffic has been strong whereas the transit traffic in liquids has diminished.

The port organisation has not set any conditions as to the condition of a vessel or the competency of its crew with regard to its arrival into port.

The supervisory role of the port authority is light and this role has not been wanted to be understood as being a significant safety factor. It has, however, a significant effect on safety. One could also ask, 'Does the harbour authority consider itself competent to oversee its own directives?'

The Rules and Regulations of the Port may also give a clear control duty to the directors of the port, as in the Port of Rauma. There is no mention of either safety or control in the management regulations of Hamina.

By using a checklist responsibility is, in effect, passed from one handler to another. The correct attitude towards the points on the safety list helps to predict accidents. Filling out the checklist is not necessarily viewed as a factor for improving safety. The updating and the checking of the list prior to loading/unloading needs to be taught practically to the person responsible for the list. There are also communication problems between the terminal operator and the ship relating to the processing of the list and the inspections to be performed. Some of these problems have been reported.

The development of safety is, to some degree, a question of competence in both targets under review.

The responsibility for formulating an overall safety picture rests with the port organisation which issues guidelines allowing or disallowing certain operations within the area they own. Operations and safety should be viewed in such a way that overall safety in the port is the joint responsibility of both the port authority and the operators in the same manner that they take care of fire safety and security. Resources for this action should be arranged in proportion to the risks involved in the upkeep of safety.

The licencing procedure could be the instrument through which overall safety can be ensured. This procedure could be developed in such a way that the operators and port authorities are ’forced’ into closer cooperation with regard to questions of safety. The results of this cooperation should also be followed and evaluated.

2.3 Crystal Pool (time charterer)

Crystal Pool time chartered the mt CRYSTAL RUBINO from the FINBETA shipping company on a month-to-month basis. The time chartering contract was drawn up using the ’SHELLTIME 4’ format which sets out the ’rules of the game’ for both parties. The contract stipulates, amongst other things, that the owner must abide by national and international regulations with regard to the seaworthiness of the vessel, both technically and with regard to its equipment and its crew.

The vessel must be manned with a competent and fully-trained crew having valid competency certificates entitling them to operate the chemical vessel in question. The vessel must be capable of transporting all substances listed on the Certificate of Fitness (’Neonol’ is one of these substances). The owner shall also guarantee that the vessel has approval from all the recognised chemical companies during the charter with regard to their inspection requirements (such companies include Exxon Mobil, BP Amoco, Arco, Basf, etc.). The charterer (Crystal Pool) has the right to inspect the vessel during the duration of the charter agreement if this is deemed to be necessary. The charterer has not exercised this right, however, because he considers it sufficient that the customers have inspected and approved the vessel.

On a general level, Crystal Pool’s obligations in its charter contract are mainly commercial and the owner of the vessel has to take care of the vessel itself and its operation.

2.4 About the chemicals handled in Hamina

2.4.1 Nonyl phenol ethoxylate, nonyl phenol

Based on the information received from the ship on the day of the accident, the substance nonyl phenol ethoxylate (’Neonol’) could be regarded as relatively harmless. The substance and its effects are discussed in Section 1.7. In the autumn of 2000, the investigators were still under the impression that the substance belongs to MARPOL category

D. In fact, it belongs to MARPOL category B which means that the substance causes considerable damage to the marine environment.

Nonyl phenol has been found to work like oestrogens in male fish, male birds, male hares and male rats resulting in considerably weakened, or ceased, production of milt/sperm.

Other chemicals affecting hormone production include PCB compounds, DDT, dibutyl phtalate, tributyl tin oxide and various other industrial chemicals and pesticides which can accumulate in animals and humans over the course of time from the underlying concentrations which exist in the environment.

2.4.2 Other chemicals

The following gives a brief outline of some of the other chemicals which are processed in Hamina. The purpose of this is to give a basis for assessing damage in the event of leakage due to overfill of some chemical other than nonyl phenol ethoxylate, which was considered harmless.

STYRENE

Health effects

Splashes irritate and dry the skin. The vapours irritate organs and the mucous membrane in the nose and throat. Solvent fumes can cause headache, dizziness, nausea and, in large concentrations, vertigo. Recurring skin contact can cause eczema due to irritation.

Environmental effects

Half-life in the ground is 2 to 4 weeks. Toxic to fish.

PHENOL

Harmful properties

Corrosive and irritative to eyes, skin and mucous membranes. Splashes to the eyes can cause blindness. Phenol is quickly absorbed into the body by inhaling the vapour, through the skin and when ingested. In cases of acute poisoning, phenol affects the central nervous system causing headache, dizziness, ataxia, dimming of vision, quick and irregular respiration, weakening of the pulse, unconsciousness and fainting. Ingestion can corrode the lips, mouth and digestive organs. Recurring exposure can lead to chronic poisoning causing headache, dizziness and digestive and mental disorders. Renal and liver damage has also been reported. Suspected carcinogen (causes cancer). Mutations have been observed in humans. Laboratory tests have revealed malformations.

Phenol is a flammable substance and releases a gas which may form an explosive compound with air.

Environmental hazards

Disappears completely after two days in the ground. May have effects on water fauna at concentrations of less than 1 mg/l.

METHANOL

Harmful properties

Toxic when inhaled or ingested. Methanol vapour concentrations that clearly exceed the HTP value cause headache, tiredness, nausea and irritation to the mucous membranes. Exposure to large concentrations causes dizziness, affects the central nervous system and causes temporary or permanent vision impairment. Methanol splashes and vapour irritate the eyes and skin. Methanol is absorbed through the skin and exposure to great amounts may cause symptoms of poisoning. A 15 ml dose of 40% methanol has resulted in death when ingested, but the normal lethal dose is 60–250 ml. Methanol first causes a drop in the level of consciousness and then, hours later, nausea, vomiting, temporary or permanent blindness, metabolic acidosis and liver and renal damage. Ingestion of a 4 ml dose of methanol has caused blindness.

Environmental hazards

Methanol mixes with water and evaporates. Its half-life is about five days in shallow water (1m). In the air, methanol disintegrates with hydroxyl radicals and its half life is about 18 days. The substance washes away with the rain. Methanol which has leaked onto the ground quickly evaporates from the land surface. As the substance is water soluble, it may permeate through to the water table. Toxic to fish.

BENZENE

Harmful properties

Causes cancer risk. Extremely flammable. Toxic: long term exposure may cause serious health damage if inhaled, if in contact with the skin or if ingested.

The substance may result in immediate poisoning when ingested resulting in nausea and vomiting. It is also absorbed through the skin into the system. Benzene affects, in the main, the respiratory system. Causes headache, dizziness, arrhythmia, hypotension, shortness of breath, agitation, spasms, narcosis, dysfunction of the cardiac vessels, respiratory arrest and death.

Benzene is clinically proven to cause cancer when inhaled, leukaemia, Hodgkin's Disease and tumours in the lymphatic tissue. The lowest concentration resulting in death to humans when inhaled is 20,000 ppm/5 min–65 mg/l/5 min. Inhalation and ingestion has caused blood changes and elevated body temperature. Also results in poisoning syndrome after skin contact. Effects have already been detected at less than 1 ppm. In chronic poisoning, commencement of the syndrome is gradual with symptoms of weakness, headache, dizziness, nausea and loss of appetite. Initial general complaints are weight loss and weakness. Subsequent symptoms may include paleness, nose and gum bleeds, heavy menstruation, capillary hematomas and red spot disease. Symptoms may vary greatly from person to person.

Environmental effects

Dissipates easily into the ground. Solubility in water is 700 mg/l. It most likely spreads into the environment with water. Toxic to fish.

At the time of the accident, and during the investigation, no benzene loads were processed in the Port of Hamina.

2.5 Activities on the CRYSTAL RUBINO

According to the safety management system on board, the crew of the vessel shall inspect the loading equipment before arrival at the loading terminal and these inspections shall be recorded. The following may be said of these inspections:

The pre-loading checks of the upper limit alarms (96% and 98%) had been performed on 12 June 2000 and on 21 July 2000 when it was noted that the 98% upper limit alarm for tank 1P was not functioning. No evidence of checks performed between these two dates could be found. During this period the ship had visited four loading ports, including Hamina on 20 July 2000.

The decreed monthly inspections of the upper limit alarms and the surface gauges had been performed on 13 May 2000 when the 98% upper limit alarm for tank 1P had been changed (changed 98%). During the following monthly inspection on 27 July 2000, it had been observed that the 98% upper limit alarm did not function. In the inspection on 12 June 2000 the alarm is marked as functioning. According to the mate who was supervising the loading in Hamina which resulted in the accident on 20 July 2000, the 98% limit alarm did not function. The loading would have been discontinued immediately had this 98% alarm reached the loading control room (interrogation record, 26 July 2000). The alarm was tested after the accident and the navigation inspector at the scene reported it as functional. A responsible mate should monitor the surface gauge reading of the tank that is being filled without averting his eyes. In this case, this was not done. The ship's loading must not be based on alarms but on the visual monitoring of the surface gauge.

As the ship was being loaded on 14 and 15 July 2000 at Wilhelmshaven, and later during an inspection in Mussalo on 21 and 22 July 2000, there was no evidence of an inspection of the P/V valves (Pressure/Vacuum, over/under pressure valves) of tanks 1P and 1S. The monthly inspections of the loading valves performed on 13 July and 1 August 2000 are in order.

A report was found on board the vessel of repairs being done to the discharge valve of tank 1P on 21 July 2000.

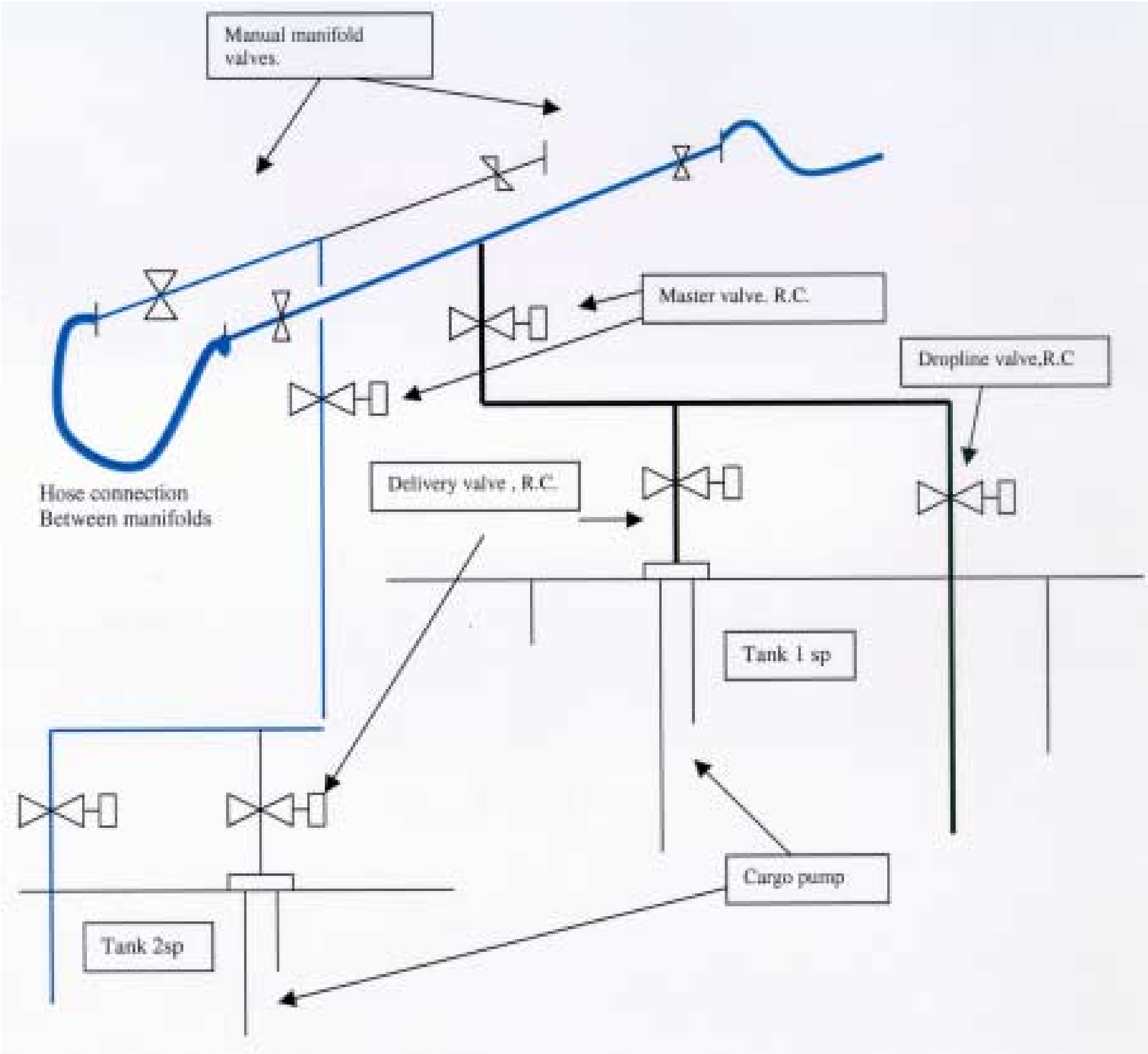


Figure 9 Loading pipeline of the CRYSTAL RUBINO, blue pipeline shows the route of the cargo to tank 2S.

Inspections of the cargo handling equipment were duly performed after 20 July 2000. There was no loading or cargo handling plan found on the vessel for the loading in Hamina on 20 July 2000. A loading plan has indeed been made since 21 July 2000 but there was no evidence of the existence of cargo handling plans. Cargo tank 1P has a capacity of 287,923 m^3 at 100% with the surface gauge showing a 41 cm shortage. The upper limit alarm of 96% will sound at 84 cm ullage (shortage) when there is 275,426 m^3 of cargo in the tank (at a trim of 0.9 m to stern). The upper limit alarm of 98% will sound at 70 cm ullage (shortage) when there is 281,507 m^3 of cargo in the tank (at a trim of 0.9 m to stern). After the 96% alarm, 12,497 m^3 of cargo flowed into the tank until it began to overflow through the ’wash hatch’, which is to the left (P) of the actual tank hatch. The mate was supposed to load 300 tons into the tank corresponding to 98.2% fill and 66 cm ullage (shortage).

According to the mate (interrogation on 26 July 2000) the main cause of the accident can be found in the valves, (the investigators have only discovered a malfunction in the discharge valve, which would not cause an overflow situation in this type of operation provided that the main valve was functional). The other reason was the computer. According to the mate's report, the computer did not show what it was supposed to show. Since both computers are connected to one another, both machines showed false information. The mate said in his statement that this had occurred again the same night when loading the other tanks. The surface gauges had functioned normally.

Figure 10 Ullage hatch of tank 1P

During the review conducted on 14 November 2000, nothing was found of an inspection log nor any mention of the above deficiencies on the day mentioned by the mate. The inoperation of the 98% upper limit during the loading was the only item reported on the inspection log dated 27 July 2000.

The tank hatches and the surface gauge had been installed in the rear part of the tank. The surface gauges are of the Saab radar type (no mechanical float). The gauges have a direct online connection to the control panel in the vessel's loading control room and to the Consultas cargo computer.

To summarise the explanations received from the vessel regarding the mechanism by which the accident occurred, it can be stated that they do not provide answers consistent with the actual flow of events. After the mate signed off the 96% fill alarm, his attention was diverted from the loading. Because the alarm on deck was muted, no one on the deck or on the pier spotted the tank overload before the chemical started to spill out onto the deck.

The valves of the tank were open, the valve of tank 2S was also open, valves of tank 1P were shut after the overload occurred. Loading into tank 2S was later continued through the same manifold. The valves of tank 1P were shut at the time and were not leaking, i.e. they were functioning normally.

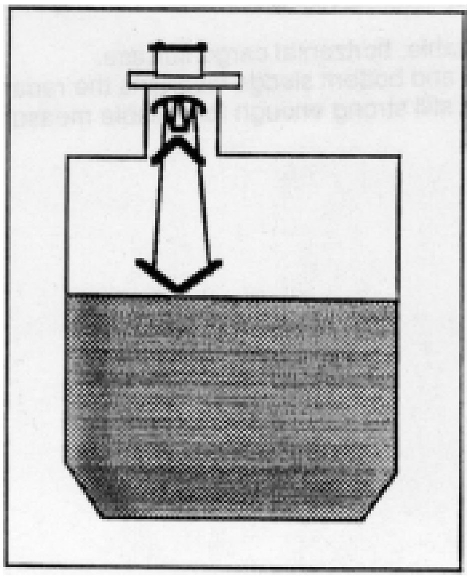


Figure 11 Operational principle of radar-type surface gauge.

Why did the cargo spilling onto the deck from the overfilled tank end up in the sea?

The cargo spilled onto the deck from the open rear hatch of tank 1P.

On the deck, the cargo flowed towards the port side ullage hatch and and then into the sea because the ullage hatch valve was open. All the drainage hatches near the railing were also open. The fact that the ullage hatch valve and the drainage and tank hatches were open proves that the ship/shore checklist was ticked without inspecting the physical status of the items on deck. The instructions on item a13 of the check list state that it shall be checked ’in situ’ (at the location) that these hatches and valves are shut.

When the chemical spilled onto the deck and into the ullage hatch, the open hatch valve was not shut immediately. Liquid was still coming out of the ullage hatch when the fire brigade duty officer arrived on the scene.

2.6 Activities ashore

Prior to the loading, the shift foreman from Kaukomarkkinat Oy went on board and gave the mate the checklist. The mate returned it a couple of minutes later all filled in. The shift foreman did not sign the list, only the mate. No checks were made. According to the shift foreman, they always receive a ticked list and the matter is thereby closed. Kaukomarkkinat Oy did not deliver anything to the ship that concerned the loading operation or the safety in port, only the checklist. As stated previously, the OCIMF safety guide for ships and terminals 'International Safety Guide for Oil Tankers and Terminals' (ISGOTT) can be considered the industry standard. When the operative director of Kaukomarkkinat Oy and the shift foreman who had started the loading were asked about this guide, it became obvious that neither of them was familiar with it. The shift foreman has 15 years' work experience and the operative director had held his post for 10 years. He had passed the safety advisor examination for the transportation of hazardous substances in the spring of 2000.

It has been the practice in Kaukomarkkinat for it to look after its own pipelines and pumps while the vessel has been expected to look after its own. This operational model is not good and it does not accord with the requirements of the international industry standard.

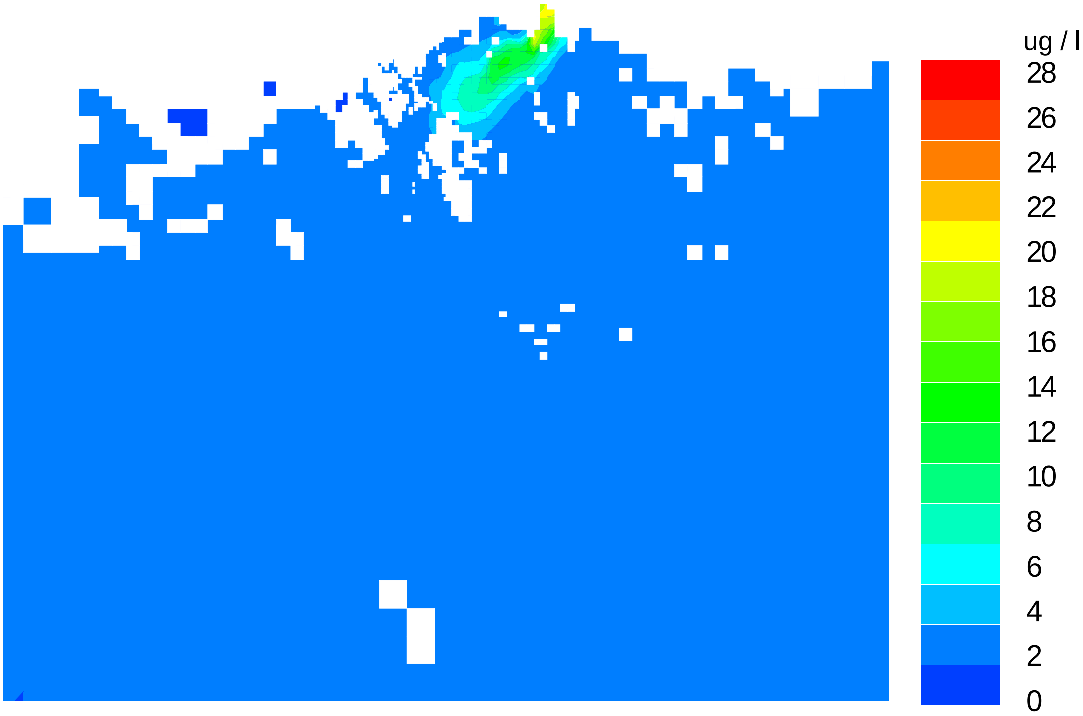
2.7 Amount of chemical which leaked into the sea and its dissipation

The amount of overfilled liquid was –2.267 tons according to the difference between the bill of lading and the tank measurements taken on board. This can be considered the minimum amount of liquid which was overpumped. According to the witness statements and other observations, this amount is probably fairly accurate.

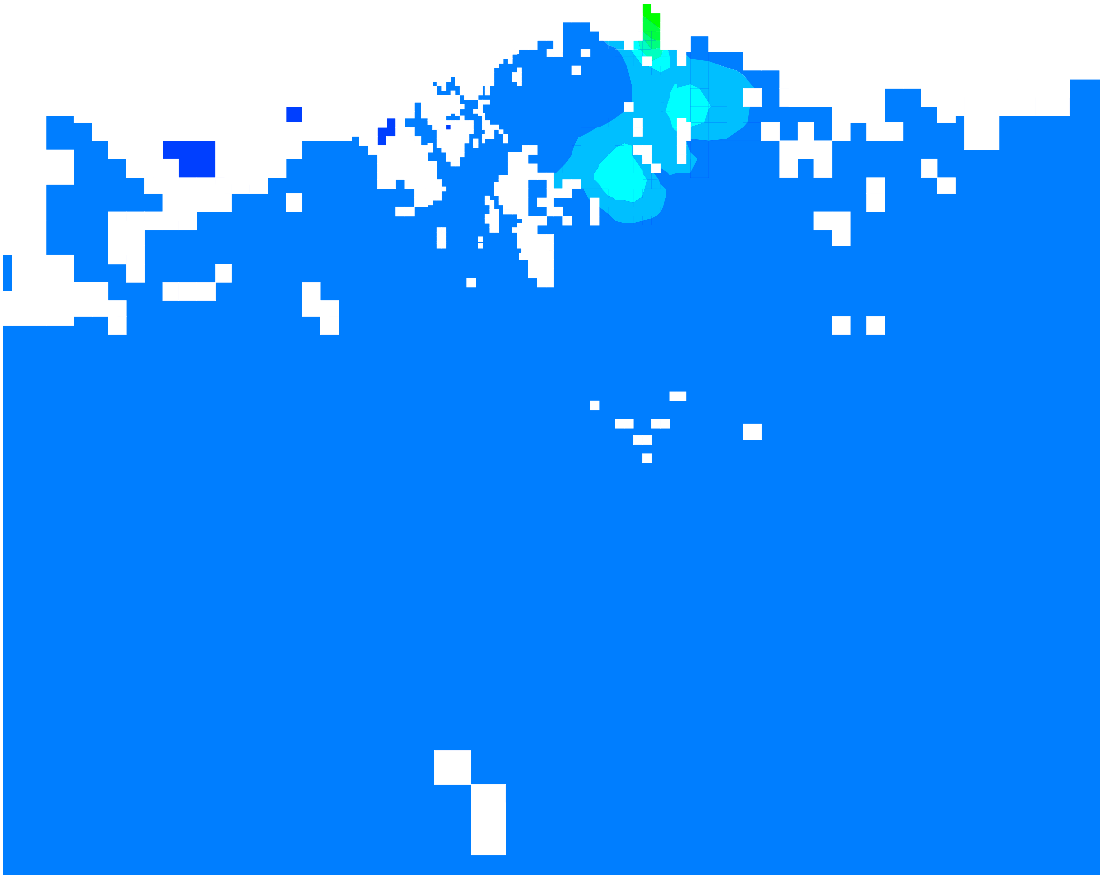
The Finnish Environment Centre (SYKE) made a model of the dispersion of the liquid in the vicinity of the Port of Hamina when the nonyl phenol ethoxylate leaked into the sea. The model was made for various amounts as follows:

Estimated amount of substance leaked into the sea 2 tons.

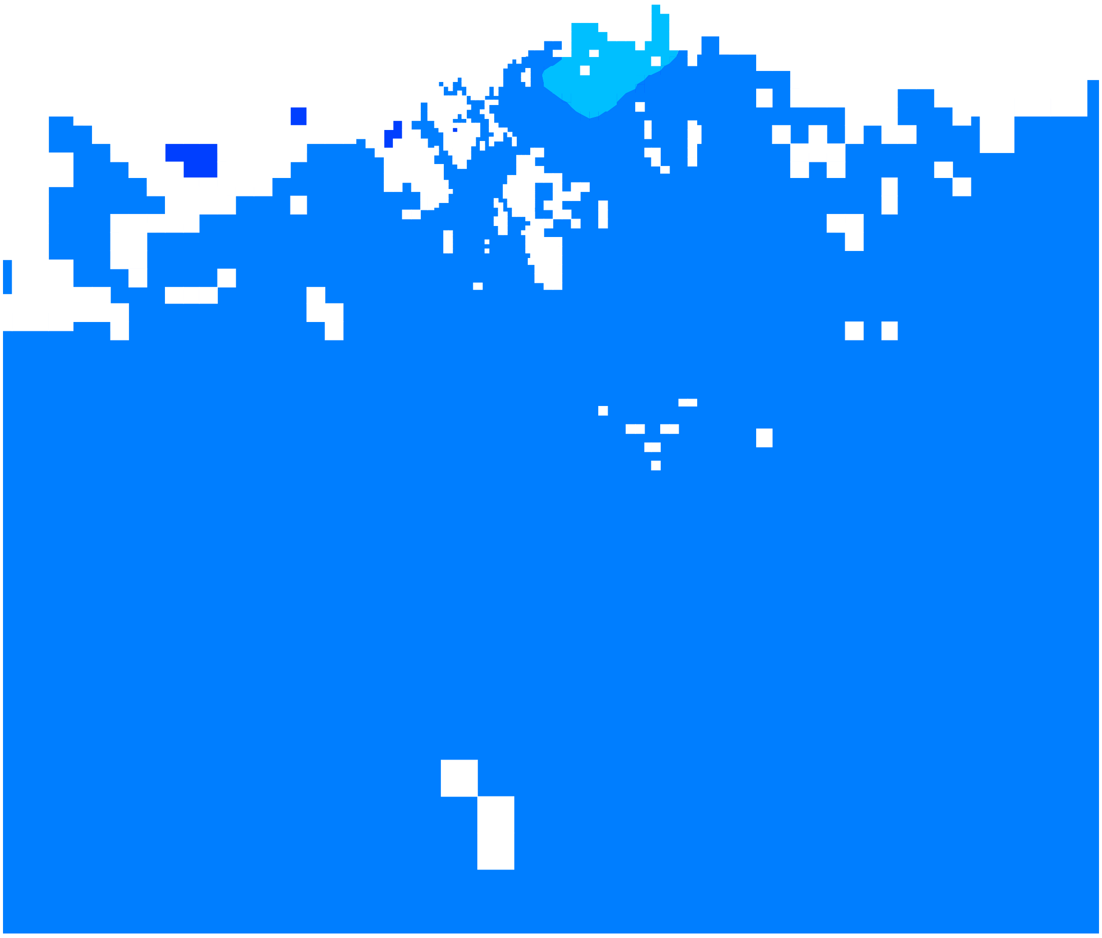
Discharge 2 tonnes off Hamina on 20 July 2000.
Spreading 1 week after the accident (27 July 2000).
Minimum detectable concentration 2 µg/l.



Discharge 2 tonnes off Hamina on 20 July 2000.
Spreading 2 weeks after the accident (3 August 2000).
Minimum detectable concentration 2 µg/l.

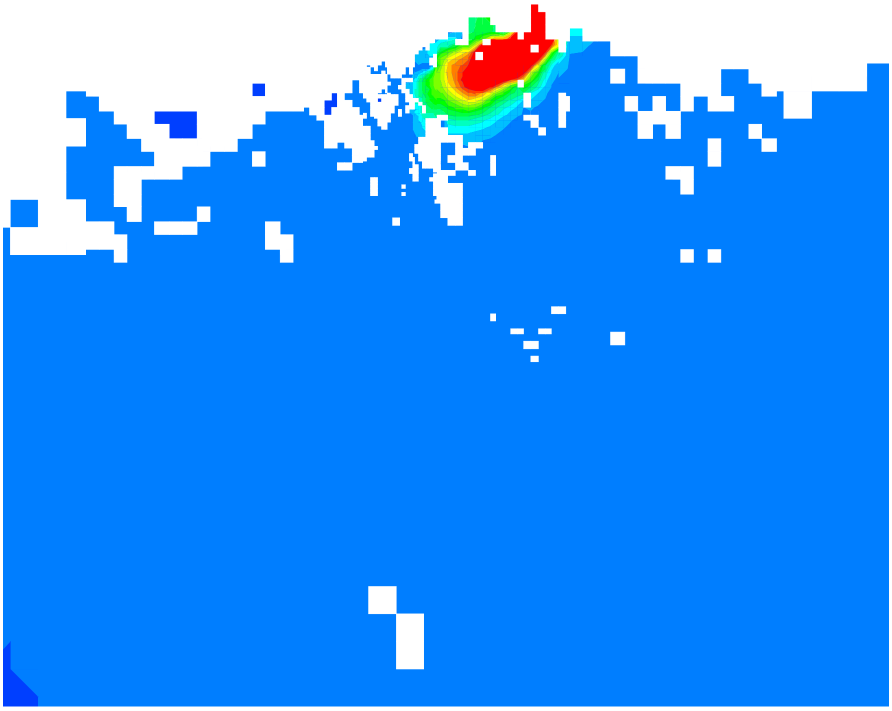


Discharge 2 tonnes off Hamina on 20 July 2000.
Spreading 4 weeks after the accident (17 August 2000).
Minimum detectable concentration 2 µg/l.

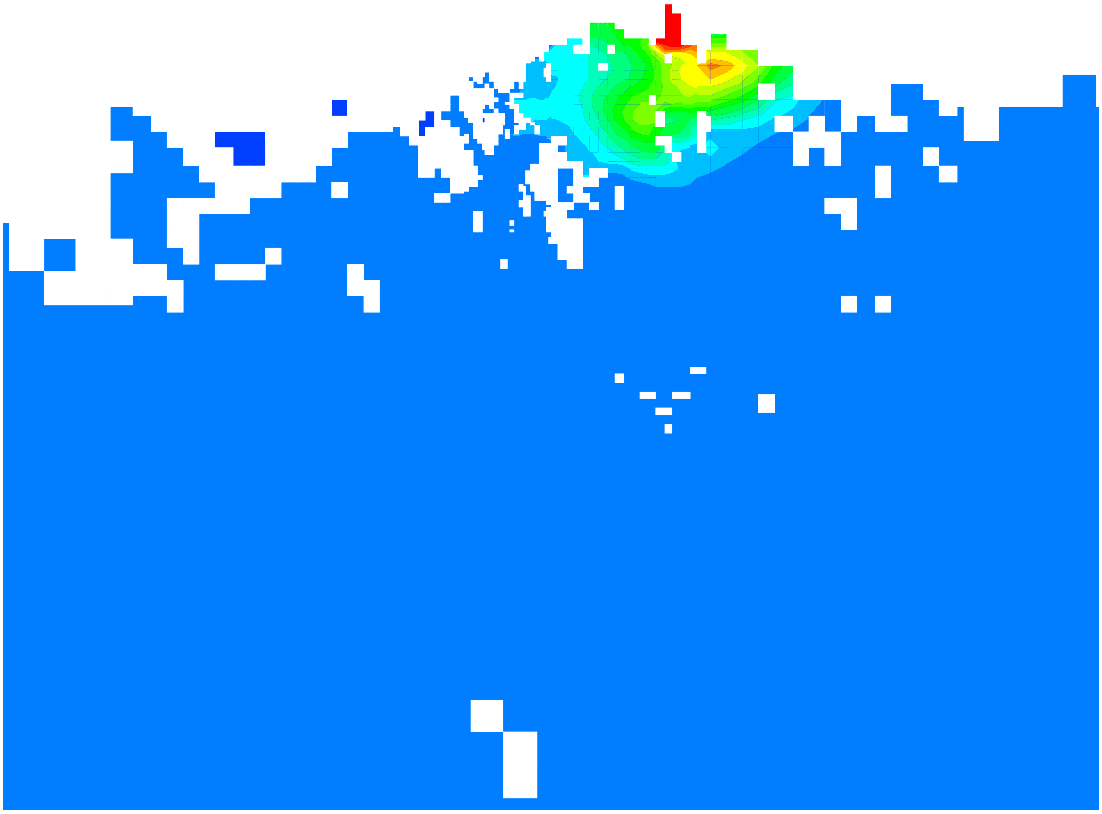


Estimated amount of substance leaked into the sea 10 tons. Scenario if the pier watch had been in the pier house and it would have taken 4 minutes to shut the valve after the overfill started

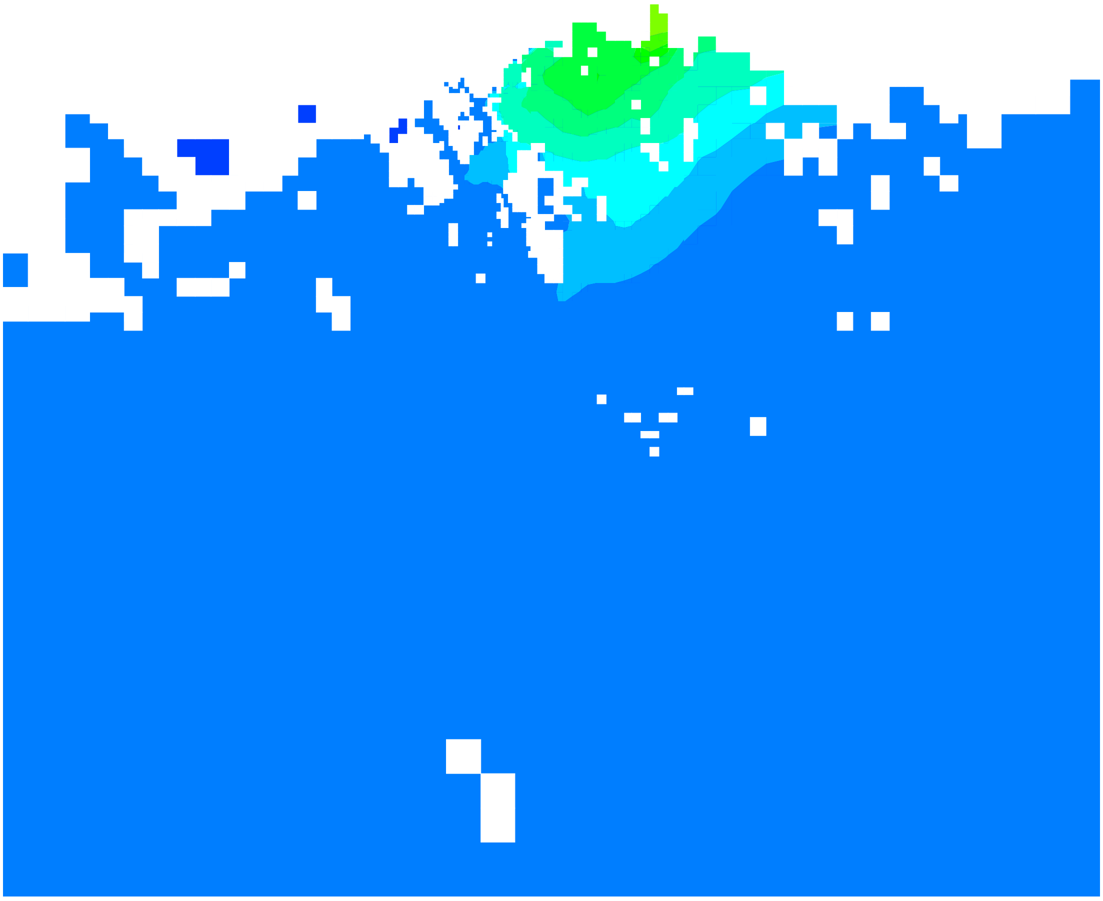
Discharge 10 tonnes off Hamina on 20 July 2000.
Spreading 1 week after the accident (27 July 2000).
Minimum detectable concentration 2 µg/l.



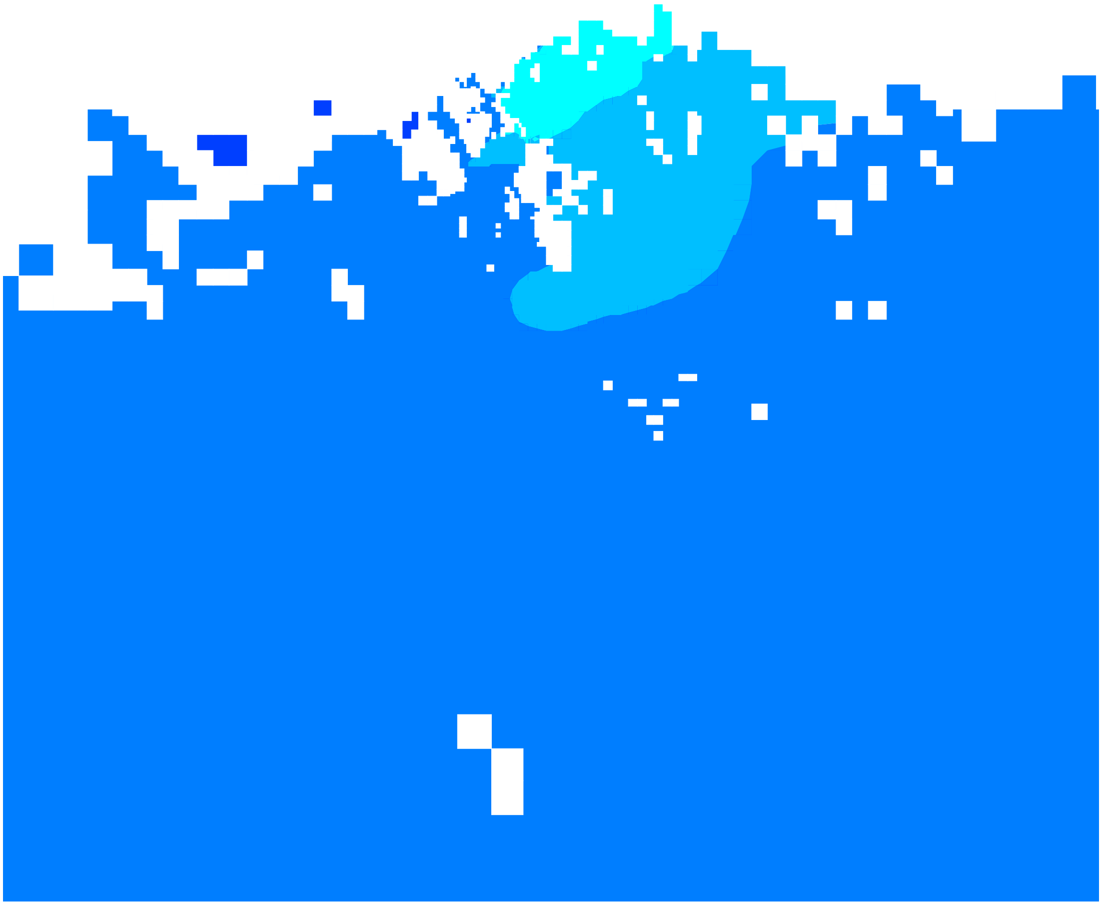
Discharge 10 tonnes off Hamina on 20 July 2000.
Spreading 2 weeks after the accident (3August 2000).
Minimum detectable concentration 2 µg/l.



Discharge 10 tonnes off Hamina on 20 July 2000.
Spreading 4 weeks after the accident (17 August 2000).
Minimum detectable concentration 2 µg/l.



Discharge 10 tonnes off Hamina on 20 July 2000.
Spreading 8 weeks after the accident (14 September 2000).
Minimum detectable concentration 2 µg/l.



2.8 Safety procedures

2.8.1 Distress signal and initiation of rescue activity

The shift ashore changed at 1400 and another shift foreman started his shift. He came onto the pier to act as the pier watch at around 1600. At about 1610 he was on the pier when he heard shouting 'stop, stop, stop' from aboard the ship. Men were running to and fro on the deck. Something was leaking into the sea and onto the pier through a drainage hatch at the ullage tank. The shift foreman ran to the pipe joint where he pressed the emergency stop button. Then he moved to the other side of the pipeline and screwed shut the pier valve. After this he telephoned the regional alarm centre and reported the incident. He was in radiotelephone contact with his own superior and he told him what had happened. The shift foreman's actions after he detected the overfill can be considered consistent and appropriate.

Figure 12 Control room of the representative of the terminal supervising the loading on the second floor. The room below is for the port supervisor. The pier is equipped with oil prevention gear (oil barriers and boat), not in the picture.

The pier watch is not always on the pier but he may also be in the pier house. The control room is on the second floor. If shouting is agreed as the method of communication, it cannot be heard in the control room. The control room offers limited visibility of the ship because the pipelines obstruct the view. In the control room there are emergency stops for the loading pumps of Transkem Oy, Kaukomarkkinat Oy and Suomen Petrooli Oy. However, the pipeline valves can be shut manually on the pier.

Figure 13 Limited view from the pier control room to the ship. Left in the picture the remote start for fire pumps and controls for fire cannons

The companies operating on Pier 2, excepting Kaukomarkkinat Oy, had a cabled, portable emergency stop for the loading pumps. The device is initially hoisted onto the vessel's railing so that the crew on board can stop the pumping. After the accident, Kaukomarkkinat installed a similar device.

Figure 14 Cabled emergency stop button of Kaukomarkkinat for loading pump (circled). Can be attached on the railing of the vessel. Installed after the overload of the CRYSTAL RUBINO.

2.8.2 Activity by the authorities

By the time the fire brigade chief and the crew from the rescue services arrived at the scene the emergency was almost over. The fire brigade chief soon became aware that the substance that had leaked into the sea was water soluble and could not be collected from the sea. All that remained was the deck rubbish collected by the ship's crew which had been piled onto the pier, and the cleaning of the pier itself. The police and the environmental authorities who had arrived at the scene initiated the accident investigation and its consequences. Later, a navigation inspector also arrived to study the seaworthiness of the vessel and to assist the police in matters concerning ship technology and maritime legislation.

The authorities organised an information session for the press in the early evening. Quick and comprehensive announcements ensured that the local residents received the correct information as soon as possible.

Since there were no actual prevention or rescue tasks, it remained for the rescue services to assist the environmental authorities in taking samples. The local police agreed that the Central Criminal Investigation Police would be responsible for the preliminary investigation. The Harbour Master sent a representative to the scene. The navigation inspector was present and the Accident Investigation Centre's representative arrived later. Representatives of the ship and the cargo owners were present. Several different participants were present on Pier 2 and on the CRYSTAL RUBINO, each carrying out their own duties. Nobody was in overall charge of the activity. It has been suggested to the investigators that similar situations should be jointly reviewed by the authorities. The first steps regarding this issue have been taken in the South Kymenlaakso area.

Figure 15 Situation on the pier about 4 hours after the accident

2.8.3 Piers

The piers in chemical ports are traditionally rather short without an immediate background area. A bridge or a narrow isthmus usually leads to the actual tank/production area. The arrangement in the Port of Hamina on piers 1 and 2 is similar to this. Over the years, new operators have established themselves on these piers with new pipelines. The isthmus has been filled and trafficking to the ship at the pier has become more difficult. The accident on the CRYSTAL RUBINO took place at Pier 2, which is not yet completely blocked like Pier 1. This pier cannot be reached by vehicles. Even going to the ship on foot often requires climbing over pressurised loading hoses.

The conditions on Pier 1 would make it difficult to mount an evacuation and rescue effort if an accident requiring this kind of activity were to happen.

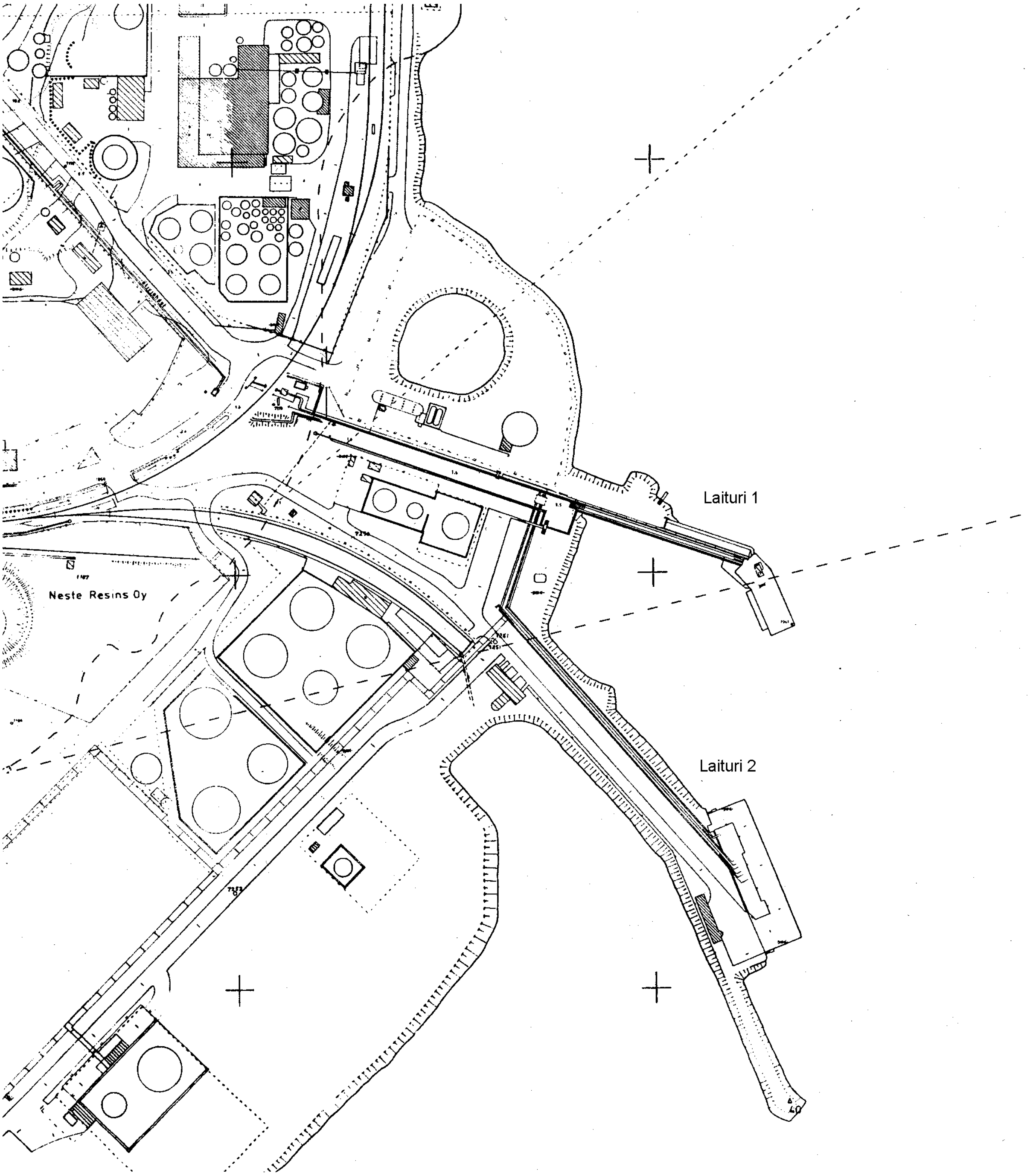


Figure 16 Piers 1 and 2 of the chemical port

2.9 Practices in other ports

The Port of Rauma is a municipal port as is Hamina. The decision making has been the same as it was earlier in Hamina, in other words the Port Board has been responsible for directing the activity. The transformation of the Port of Hamina into a business unit and its subsequent privatisation into a limited company make the ports different.

In Rauma, the control duty is written into the Rules and Regulations. The official role of a municipal port is traditionally not very strong. There is no written safety policy or safety objectives. The agent's task is to inform incoming ships of the safety regulations to be observed in the port. The port authorities have regular meetings with their joint partners.

Vessels visiting the port are not actually inspected. The port supervisors monitor the environment, the general order and neatness and any possible discharges from the vessels in the port area. The port organisation has its own security in the port area whereas the operating companies have organised their own security.

In the Port of Rauma, the ship/shore safety checklist is seen as a central tool in the management of safety between the ship and the terminal. The structure of the list is based on international recommendations.

The Port of Rotterdam in the Netherlands is the largest port in the world. About 9,000 tankers and 20,000 general-cargo ships visit the port annually.

The city of Rotterdam exercises the power of decision over its municipal port, which falls within its jurisdiction. The port organisation employs a total of 800 persons. The Harbour Master is the director of the organisation and is responsible for its safety. A unit controlling vessel traffic at sea, operations in the port, the processing of hazardous substances and the related reporting practices acts as the port authority. The port receives prior notification of all hazardous cargoes. Inspection activities are, in the main, based on prior notification. The port authority controls ship safety by means of inspections. These inspections are carried out to ensure that the ships operate according to the rules. The inspectors perform 4,500 MARPOL inspections and 8,000 other inspections per year.

The municipality of Rotterdam enforces the Port Ordinance. There is no written safety policy or safety objectives. The agents are informed of any changes in the port or in its rules. The agent's task is to inform incoming ships of the safety regulations to be observed in the port. The port authorities have regular meetings with their joint partners.

A register is kept of the vessels visiting the port and from the collected data a historical knowledge of the vessel accumulates. The port authority does not evaluate the safety activity of the port operators. Internal activity is evaluated mainly from the viewpoint of quality development.

The authorities write 2,000 reports (inspection logs) annually concerning the processing of hazardous substances. The sanctions are considered sufficient. Vessels in a poor condition are considered a serious safety risk. There is no prior criteria for refusing entry for a vessel.

The terminal operator is responsible (for his part) for the loading and unloading of a vessel and agrees about the procedures with the ship. When the ship is moored to the terminal pier, it becomes a part of the jurisdiction of the terminal. In other words, the ship must operate according to the rules of the terminal. The port authority is not involved as an active party in this process.

Communication with the ships is not experienced as being problematic. The port authority assesses the effect of its own control and there is a person assigned for the development of control and safety.

The role of the port authority is clearly different from the role of the port authority in Finland. In Rotterdam, the authority controls the activities and inspects ships in order to maintain safety.

Example of a terminal operator in Rotterdam

There are 65 employees in the terminal chosen as the example. There are four berths at the terminal: two for marine traffic and two for inland waterways traffic. There are 89 tanks in the terminal with a total capacity of 330,000 m^3 . All kinds of substances can be handled.

The following visit the terminal each year: 450 marine ships, 600–700 inland ships, 7,000 vehicles and 2,500 railway cars. The terminal handles both loading and unloading.

The company has a written safety policy and objectives. Safety is a priority on the agenda. Safety is regularly addressed in the company board meetings.

The company has the ISO 9000 quality system and the safety instructions are built into the system. The company is implementing the Responsible Care safety programme for the chemical industry.

There are eight people on duty per shift. The shift foreman handles the starting procedures with the ship. There are always two men from the terminal on the pier when loading is started/stopped. During the cargo handling operation, there is at least one person on the pier.

There are two fire drills per year so that each employee participates in at least one of the drills every year. A larger drill with the fire brigade is organised once a year.

There is no portable emergency stop on the pier which could be given to the ship for the loading operation.

Any changes to the operation require a licence from the authorities or their notification.

Safety is improved by regular discussions with the personnel. Maintaining a high level of motivation is considered important. There are also different information campaigns. The working conditions are monitored constantly and internal feedback from the organisation or from the authorities is heeded.

3 CONCLUSIONS

3.1 Direct causes of the accident

A hazardous chemical leaked through an open tank hatch onto the deck and from there onto the pier and into the sea because the supervision of the loading was not carried out with sufficient care.

3.2 Factors leading to the accident

On reviewing the events preceding the accident it can be concluded that the chain of events began because:

(1) The competence of the mate supervising the loading was insufficient.

(2) The inspections of the upper limit alarms stipulated to be performed before the loading were neglected.

(3) The safety inspection before the loading was not conducted and the checklist was not filled in in the appropriate manner.

(4) Contrary to good seamanship practice, the master and the first mate left the mate (who had little experience of cargo handling) alone to supervise the most critical activity in the loading of a tanker, i.e. the filling of the tank; and

(5) The definition of the deck hands' tasks and the directions for them was not precise and the deck watch did not know what his role was in the supervision of the loading.

The procedures ashore for the preparation and supervision of the loading were not sufficiently directed, for instance with regard to the Safety Check list.

Random control of the ship/pier activity by the authorities is one of the underlying factors.

3.3 Facts discovered in the investigation

At the time of the accident, nonyl phenol ethoxylate was reported to belong to MARPOL category D. Considerably more information was received during the investigation about the chemical and its properties. Handlers of the chemical and the authorities are not sufficiently aware of its true properties.

4 RECOMMENDATIONS

Control by the authorities during loading and unloading operations

As clearly presented in the standard for the industry and in the IMO recommendation, according to the checklist a joint inspection should actually be carried out with regard to those relevant points as a joint operation. In order to make sure the parties actually do this, periodic verification by 'a third party' is needed.

This 'third party' could be the port operator or the navigation inspector of the PSC/flagging state. The IMO 'Recommendation on the Safe Transport, Handling and Storage of Dangerous Substances in Port Areas' should be incorporated into the Finnish legislation. If the matter is considered a part of occupational safety, spot- check-type inspections could be made a part of the occupational safety inspections. However, this would require a considerable increase in the frequency of the inspections from the present level. Other authorities, such as the rescue authorities, the environmental authorities or TUKES could also perform this type of control.

It is the recommendation of the investigation board that:

1. *The control of safety activities in the loading and unloading of bulk chemicals, such as the filling in of the ship/shore safety checklist, should be improved and made more frequent. The responsibility for this belongs to the authorities. Of the authorities already involved in the area, one authority alone, or several authorities in co-operation, could act as the controlling authority. The Ministry of Transport and Communications, Ministry of the Environment, Ministry of Trade and Industry, Ministry of the Interior and the Department of Occupational Safety at the Ministry of Social Affairs and Health should initiate proceedings for organising this control.*

Cooperation between the port operator and the companies operating in the port

The port operator is responsible for outlining general safety in the port. It issues directions and allows/does not allow the activities defined by it in the area it owns. The operations and safety should be looked at in such a way that the operators in the port would jointly hold the responsibility for the overall safety whereas the port operator would direct the activities, in the same way that fire safety or security is organised at present. The resources for this activity could be organised in proportion to the risks and maintenance of safety. Licensing could be the instrument for managing the overall safety. The procedure could be developed in such a way as to 'force' the operators and the port operator into closer cooperation regarding safety issues. This cooperation and its results should also undergo follow-up and monitoring.

It is the recommendation of the investigation board that:

2. *The owner of the Port of Hamina clarifies the rules to be observed in the port and the role of the port operator as the port authority. Matters relating to licensing, re-*

sponsibilities and obligations with considerable effect on the chemical port entity should be made sufficiently clear for there to prevail a uniform understanding of the issue among the port operators. This calls for updating the port rules to include a clear definition of the duties and controlling obligations related to safety.

Nonyl phenol ethoxylate

Since it became evident during the investigation that not all the properties of the substance that leaked into the sea were known, and that its category regarding hazards to the environment in the MARPOL classification was not clear to all, it is the recommendation of the investigation board that:

3. The Finnish Maritime Administration be active in the IMO to ensure the correct MARPOL category for nonyl phenol ethoxylate.

Helsinki, 1 July 2001.

Risto Repo | Juha Sjölund | Ilkka Pelli

ANNEXES

The following annexes are on file at the Accident Investigation Centre:

1. Police interviews.
2. Safety activities in the Port of Hamina, review.
3. Interview memos by the investigators.
4. Legislation and official directions used as sources.
5. Copies of records of inspections by the authorities.