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Institute for the Protection and Security of the Citizen
Technological and Economic Risk Management
Natural Risk Sector
I-21020 Ispra (VA) Italy

NEDIES PROJECT

Lessons Learnt from Maritime Disasters

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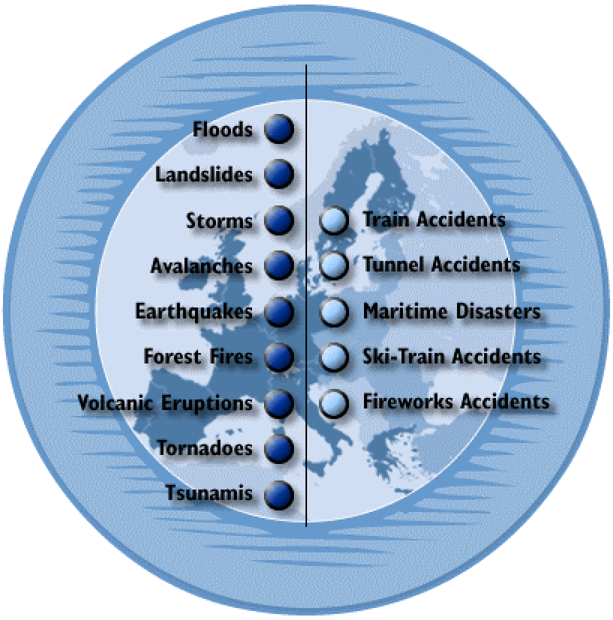

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ABSTRACT

The NEDIES project is being conducted at Ispra by the Institute for the Protection and Security of the Citizen (IPSC) of the EC Directorate General Joint Research Centre (JRC). The objective of the project is to support the Commission Services of the European Communities, Member State Authorities and EU organisations in their efforts to prevent and prepare for natural disasters and accidents, and to manage their consequences.

A main NEDIES activity is to produce lessons learnt report on natural disasters and accidents. This report discusses lessons learnt from maritime disasters. It is based on the contributions submitted by some EU Civil Protection Authorities to the NEDIES Team and also information collected from literature and the Internet.

ACKNOWLEDGEMENTS

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1. INTRODUCTION

There is no doubt that a significant number of the world's population has heard of the most famous maritime disaster: Titanic and its collision with an iceberg. Many lessons have been learnt since this historical event, which triggered the ratification of the most important international treaty concerning the safety of merchant ships: the *SOLAS (Safety of Life At Sea) Convention* in 1914[1]. Maritime disasters are relatively common events and do not often get the attention required. This report aims to portray the lessons learnt from some maritime disasters that occurred in Europe in a user-friendly manner, targeting Civil Protection authorities and the general public, so as to raise awareness on maritime disaster management issues.

During the collection of information on lessons learnt from recent maritime disasters across Europe, it is important to highlight the difficulties encountered during this endeavour. They are mainly due to the ongoing judicial investigations linked to such accidents regarding the possible existence of civil and criminal liabilities, with court cases lasting up to several years. Furthermore, in order to avoid misunderstandings and confusion whilst reading this document, it is essential to note that in this report, maritime disaster implies shipping disasters. Disasters such as oil spills are sometimes also regarded as a maritime disaster. However, in this report they are regarded as a possible effect of a maritime disaster.

This document is based on the contributions from experts in the field of maritime disasters. Chapter 2 is dedicated to the lessons learnt from various maritime disasters experienced throughout Europe. The first maritime disaster entry described is the capsizing of the ro-ro passenger vessel *MV Estonia*, derived from the final report of the Joint Accident Investigation Commission of Estonia, Finland and Sweden (Section 2.1). This is followed by the description of the fire aboard the passenger ferry *Prinsesse Ragnhild*, which is a contribution from Norway and Sweden (Section 2.2). The third event described is on the cargo ship *Ulsund - LHNW*, derived from the Joint Norwegian/Finnish Casualty report (Section 2.3). The last contribution portrays the disaster bearing upon the two Baltic herring trawlers *Lea* and *Nipsu* (Section 2.4).

Chapter 3 summarises the various lessons learnt contributions. It also offers some conclusions arising from the analysis of the contributions.

An Annex is also provided, which offers a suggestion of maritime disaster causes, along with a list of useful links pertaining maritime disasters.

This endeavour has been carried out within the framework of the NEDIES Project. NEDIES (Natural and Environmental Disaster Information Exchange System) is concerned with natural disasters and accidents, which occurred in EU Member States. It is carried out at the Institute for the Protection and Security of the Citizen (IPSC), DG Joint Research Centre of the European Commission. This lessons learnt report was made for the Civil Protection Services of the EU Member States and organisations, people involved in the management of any type of natural disaster and accidents and also the general public. Although the lessons learnt from maritime disasters are addressed in the report, many of them could also be of help in the prevention of, preparedness for and response to other types of disasters.

[1] SOLAS Convention has been amended continuously in response to lessons learnt from other maritime disasters. Due to a complete change in the amending procedure of the treaty in 1974, in response to demands in the field, the Convention is commonly referred to as SOLAS, 1974, as amended.

2. LESSONS LEARNT

2.1 MV Estonia Disaster (Estonia)

***Joint Estonian/Finnish/Swedish Accident Investigation Commission*[2]** *(Estonia, Finland, Sweden)*

2.1.1 Date of the disaster and location

28 September 1994, en-route between Tallin and Stockholm, in the middle of the Baltic Sea.

2.1.2 Description of the event[3]

The Estonian-flagged ro-ro passenger ferry ESTONIA (Figure 2.1.a) departed from Tallinn, the capital of Estonia, on 27 September 1994 at 19.15 hrs for a scheduled voyage to Stockholm, the capital of Sweden (Figure 2.1.b). The ship carried 989 people, 803 of whom were passengers.

Figure 2.1.a - The ro-ro passenger ferry ESTONIA.
© Accident Investigation Board Finland

The ship left harbour with all four main engines running. When she was clear of the harbour area full service speed was set. The engine setting was maintained up to the accident. The wind was southerly, 8-10 m/s. Visibility was good, with rain showers. At 20.00 hrs the watch on the bridge was taken by one of the two *second officers* and the *third officer*.

[2]The Joint Accident Investigation Commission consistes of the following:
For Estonia: Uno Laur (Chairman), Heino Jaakula, Jaan Metsaveer, Ministry of Transport and Communications
For Finland: Kari Lehtola, Heimo Iivonen, Tuomo Karppinen, Accident Investigation Board
For Sweden: Ann-Louise Eksborg, Hans Rosengren, Olle Noord, Board of Accident Investigation
[3] From http://www.onnettomuustutkinta.fi/estonia/chapt01.html

Figure 2.1.b - Route of the MV Estonia.
© Accident Investigation Board Finland

The voyage proceeded normally. Sea conditions along the Estonian coast were moderate, but became more rough when the ship left the sheltered waters. The ship had a slight starboard list due to a combination of athwartships weight disposition, cargo disposition and wind pressure on the port side.

As the voyage continued the wind velocity increased gradually and the wind veered to south-west. Visibility was generally more than 10 nautical miles. At midnight the wind was south-westerly 15-20 m/s with a significant wave height of 3-4 m. The rolling and pitching of the vessel increased gradually, and some passengers became seasick.

At about 00.25 hrs the ESTONIA reached a waypoint at position N 59.20 and E 22.00, and from there headed true course 287°. The speed was about 14 knots and the vessel encountered the seas on her port bow. Due to increasing rolling, the fin stabilisers were extended.

During his scheduled round on the car deck, the seaman of the watch heard shortly before 01.00 hrs a metallic bang from the bow area as the vessel hit a heavy wave. The seaman of the watch informed the *second officer* about what he had heard and was ordered to try to find out what had caused the bang. The seaman did so by waiting at the ramp, listening and checking the indicator lamps for the visor and ramp locking devices. He reported that everything seemed to be normal.

At 01.00 hrs the watch on the bridge was taken over by a *second officer* and a *fourth officer*. After being relieved, one of the *second officers* and the *third officer* left the bridge. Further observations of unusual noise, starting at about 01.05 hrs, were made during the following 10 minutes by many passengers and some crew members who were off duty in their cabins. When the seaman of the watch returned from his round, soon after the change of watches, he caught up the master and entered the bridge just behind him. Shortly afterwards he was sent down to the car deck to find out the cause of the sounds reported by telephone to the bridge. He did not, however, manage to reach the car deck.

At about 01.15 hrs the visor separated from the bow and tilted over the stem. The ramp was pulled fully open, allowing large amounts of water to enter the car deck. Very rapidly the ship took on a heavy starboard list. She was turned to port and slowed down. Passengers started to rush up the staircases and panic developed at many places. Many passengers were trapped in their cabins and had no chance of getting out in time. Lifejackets were distributed to those passengers who managed to reach the boat deck. They jumped or were washed into the sea. Some managed to climb into liferafts which had been released from the vessel. No lifeboats could be launched due to the heavy list.

At about 01.20 hrs a weak female voice called "Häire, häire, laeval on häire" the Estonian words for "Alarm, alarm, there is alarm on the ship", over the public address system. Just a moment later an internal alarm for the crew was transmitted over the public address system. Soon after this the general lifeboat alarm was given. A first Mayday call from the ESTONIA was received at 01.22 hrs. A second Mayday call was transmitted shortly afterwards and by 01.24 hrs 14 ship- and shore-based radio stations, including the Maritime Rescue Co-ordination Centre (MRCC) in Turku, had received the Mayday calls.

At about this time all four main engines had stopped. The main generators stopped somewhat later and the emergency generator started automatically, supplying power to essential equipment and to limited lights in public areas and on deck. The ship was now drifting, lying across the seas. The list to starboard increased and water had started to enter the accommodation decks. Flooding of the accommodation continued with considerable speed and the starboard side of the ship was submerged at about 01.30 hrs. During the final stage of flooding the list was more than 90 degrees. The ship sank rapidly, stern first, and disappeared from the radar screens of ships in the area at about 0150 hrs. See Figure 2.1.c for the computer-generated pictures illustrating the development of the list and sinking of the vessel.

Rescue efforts were initiated by MRCC Turku. About one hour after the ESTONIA had sunk, four passenger ferries in the vicinity arrived on the scene of the accident. Rescue helicopters were summoned and the first one arrived at 0305 hrs. The wreck was found in international waters within Finland's Search and Rescue Region, resting on the seabed at a water depth of about 80 m with a heading of 95° and a starboard list of about 120°. The visor was missing and the ramp partly open. The position of the wreck is N 59.23 and E 21.41. The visor, which has been recovered, was located at N 59.23 and E 21.39, about one nautical mile west of the wreck.

2.1.3 Human consequences[4]

During the night and early morning, helicopters and assisting ships rescued 138 people, of whom one later died in hospital. During the day and on the two following days 92 bodies were recovered. Most of the missing persons accompanied the vessel to the seabed.

Out of the 989 people on board the ship, a total of 852 persons lost their lives in the accident. Of them one died in hospital and 92 were found in the water and in liferafts during the rescue operation and the following days. No victims were found on the seabed surrounding the wreck or on the external areas of the wreck during the diving survey. Two bodies have subsequently been found in the area of the Gulf of Finland, one in the open sea and one on the shorelines of Estonia. There are still 757 persons missing.

[4] From http://www.onnettomuustutkinta.fi/estonia/chapt01.html and http://www.onnettomuustutkinta.fi/estonia/chapt08_6.html#3

The survey of the interior was only partial and essentially limited to public areas and cabins along the port side of the wreck. About 130 victims, including those on the bridge, were observed in different areas. Many victims in various localities had lifejackets on.

Of the approximately 300 people who reached the open decks, some 160 succeeded in climbing onto liferafts, and a few climbed onto capsized lifeboats. Helicopters rescued 104 people, and vessels rescued 34.

2.1.4 Economic losses

Not available.

2.1.5 Prevention measures and related lessons learnt[5]

- At the time of the ESTONIA's construction (1980), despite scattered information, the industry's general experience of hydrodynamic loads on large ship structures was limited, and the design procedures for bow doors were not well-established, thus leading to the following failures.
  - The locking devices and the hinges of the bow visor failed fully under one or two wave impact loads on the visor shortly after 01.00 hrs, due to wave-induced impact loads creating opening moments about the deck hinges.
  - The visor attachments were not designed according to realistic design assumptions, including the design load level, load distribution to the attachments and the failure mode. The attachments were constructed with less strength than the simplistic calculations required. It is believed that this discrepancy was due to lack of sufficiently detailed manufacturing and installation instructions for certain parts of the devices.
  - There were no detailed design requirements for bow visors in the rules of Bureau Veritas, the classification society concerned, at the time of the building of the ESTONIA.
  - The visor design load and the assumed load distribution on the attachments did not take realistic wave impact loads into account.
  - The bow visor locking devices should have been several times stronger to have a reasonable level of safety for the regular traffic between Tallinn and Stockholm.
  - The visor locking devices were not examined for approval by the Finnish Maritime Administration, nor by Bureau Veritas.
  - The visor locking devices installed were not manufactured in accordance with the design intentions.
  - No safety margin was incorporated in the total load-carrying capacity of the visor attachment system.
  - The attachment system as installed was able to withstand a resultant wave force only slightly above the design load used.
  - Wave impact loads generated on the night of the accident exceeded the combined strength of the visor attachments.
  - Wave impact loads on the visor increased very quickly with increasing significant wave height, while forward speed had a smaller effect on the loads.

[5] From http://www.onnettomuustutkinta.fi/estonia/chapt20.html, http://www.onnettomuustutkinta.fi/estonia/chapt21.html and http://www.onnettomuustutkinta.fi/estonia/chapt22.html

– The visor indicator lamps on the bridge did not show when the visor was detached, and the visor was not visible from the conning position. Nor did the lamps show when the ramp was forced open.
– Information on bow visor incidents was not systematically collected, analysed and spread within the shipping industry. Thus masters on board had, in general, very little knowledge of the potential danger of the bow visor closure concept.

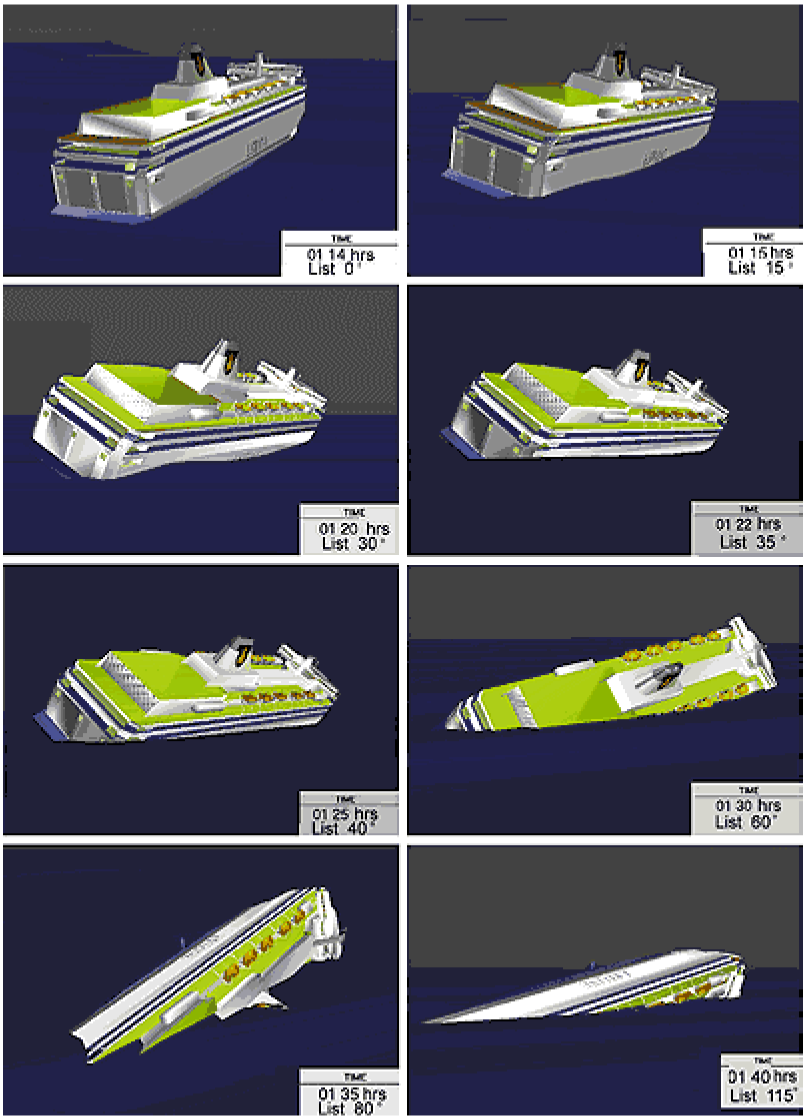

Figure 2.1.c - Computer-generated pictures illustrating the development of the list and sinking of the vessel.
© Accident Investigation Board Finland

- The ESTONIA capsized due to large amounts of water entering the car deck, loss of stability and subsequent flooding of the accommodation decks.
  – Large amounts of water entered the car deck and in a few minutes a starboard list of more than 15° developed.
  – The full-width open car deck contributed to the rapid increase in the list. The turn to port - exposing first the open bow and later the listed side to the waves - shortened the time until the first windows and doors broke, which led to progressive flooding and sinking.
  – The entry of water at the sides of the partly open bow ramp was observed on a monitor in the engine control room, but no information was exchanged with the bridge.
- The Finnish Maritime Administration was, according to a national decree, exempt from doing hull surveys of vessels holding valid class certificates issued by authorised classification societies.
- The SOLAS[6] requirements for an upper extension of the collision bulkhead were not satisfied. This non-compliance may have contributed to the vessel's capsizing.

2.1.6 Preparedness measures and related lessons learnt[3]

- The crew should have been better prepared for this event, as they would have been able to react more efficiently. This can clearly be deduced from the Estonia report:
  – The initial action by the officers on the bridge indicates that they did not realise that the bow was fully open when the list started to develop.
  – The bridge officers did not reduce speed after receiving two reports of metallic sounds and ordering an investigation of the bow area. A rapid decrease in speed at this time would have significantly increased the chances of survival.
  – The visor could not be seen from the conning position, which the Commission considers a significant contributing factor to the capsizing of the ship. In all incidents known to the Commission where the visor had been opened at sea due to locking device failure, the opening was observed visually from the bridge and the officers of the watch were able quickly to take appropriate action.
  – There are indications that the crew did not use all means to seek or exchange information regarding the occurrence at a stage when it would still have been possible to influence the development of the accident. The bridge crew apparently did not look at the TV monitor which would have shown them that water was entering the car deck; nor did they ask those in the control room from where the ingress was observed, or get information from them.
  – The position sensors for signal lamps showing locked visor were connected to the side locking bolts in such a way that the lamp on the bridge showed locked visor even after the visor had tumbled into the sea. The indirect information on the status of the visor was thus misleading. The signal lamp for locked ramp was most likely not on because one of the locking bolts was not fully extended. There was thus no lamp warning when the visor had forced the ramp partly open and it was resting inside the visor.

[6] SOLAS is the International Convention for the Safety of Life at Sea (1974). See http://www.imo.org/Conventions/contents.asp?topic_id=257&doc_id=647 for more information.

– It is most likely that the crew were unaware of visor incidents involving other vessels.

- A better evacuation manouvre should have been carried out. This can also be deduced from the Estonia report, as portrayed below:
  - – There was no organised evacuation.
  - – The time available for evacuation was very short, between 10 and 20 minutes.
  - – The lifesaving equipment in many cases did not function as intended. Lifeboats could not be lowered.
  - – The lifeboat alarm was not given until about five minutes after the list developed, nor was any information given to the passengers over the public address system. By the time the alarm was given, the list made escaping from inside the vessel very difficult. This together with problems in using lifesaving equipment contributed to the tragic outcome. The rapid increase in the list contributed to the large loss of life.
  - – The distress traffic was not conducted in accordance with the procedures required by the radio regulations.
  - – The evacuation was hampered by the rapid increase in the list, by narrow passages, by transverse staircases, by objects coming loose and by crowding. About 300 people reached the outer decks. Most victims remained trapped inside the vessel.

2.1.7 Response actions and related lessons learnt[3]

- The coordination of the response operations should be improved, as it is necessary to respond timely to the disaster. However, due to the following incidents, this was not achieved during this event.
  - – Initially the accident was not treated as a major accident. It was formally designated as such at 02.30.
  - – The alarming of helicopters was late. MRCC Turku started alerting rescue units at 01.26 hrs (approximately 1 hour after the alarm). One standby helicopter was alerted at 01.35 hrs (1hour and 10 minutes after the alarm), another at 02.18 hrs (almost 2 hours after the alarm), and the military helicopters at 02.52 hrs (2 hours and 30 minutes after the alarm). The assistance by Swedish helicopters was agreed at 01.58 hrs (approximately 1 hour and a half after the alarm).
  - – The master of the SILJA EUROPA was appointed OSC (On-Scene Commander) at 02.05 hrs.
  - – The first rescue unit, the MARIELLA, arrived on the scene of the accident at 02.12 hrs, 50 minutes after the first distress call.
  - – MRCC Tallinn was informed of the accident at 02.55 hrs by MRCC Helsinki.
  - – The first helicopter arrived at 03.05 hrs.
  - – An air co-ordinator arrived to assist the OSC at 06.50 hrs and a surface search co-ordinator arrived at 09.45 hrs.
  - – The participating vessels did not launch lifeboats or MOB[7] boats due to the heavy weather. Their rescue equipment was not suitable for picking up people from the water or from rafts.

[7] Man Overboard (MOB).

- The helicopters had a key part in the rescue operation by rescuing most of the people who had succeeded in climbing onto liferafts or lifeboats. However they should be better organised because:
  – Winch problems in three Swedish Navy helicopters seriously limited their rescue capacity.
  – One rescue man per helicopter was not enough due to the very exhausting rescue work.
  – Some helicopters carried journalists during the later rescue flights. It is deemed inappropriate for helicopters to carry journalists in critical situations and where they may encroach on the privacy of survivors.
  – The main reasons for the delay in issuing alarms in general were that the distress traffic was conducted separately from MRCC Turku, and that there was only one person on duty at MRCC Turku, at MRCC Helsinki and at Helsinki Radio, respectively.
- In the Finnish MRCCs the instructions regarding distress traffic were inadequate, and thus should be improved.
- The lifesaving equipment of vessels participating in the rescue operation proved unsuitable for rescuing people from the water in the prevailing heavy weather conditions.

2.1.8 Information supplied to the public and related lessons learnt[3]

The public should be better informed about what to do in the event of an accident, so as to assist them in being better prepared:

- The first known Mayday call from the ESTONIA was transmitted at 01.22 hrs, and at about the same time the lifeboat alarm was given. Shortly before that, a brief alarm in Estonian was given over the public address system. Just after this, the crew was alerted by a coded fire alarm. No general information was given to the passengers during the accident.
- The lifeboat alarm was not given until about five minutes after the list developed, nor was any information given to the passengers over the public address system.

2.2 Fire in the engine room aboard the passenger ferry “Prinsesse Ragnhild” (Norway, Sweden)

Berit Svensen *(Directorate for Fire and Explosion Prevention)* and ***Ulf Hallström*** (*Search and Rescue Service*)

2.2.1 Date of the disaster and location

8 July 1999, in the engine room of the passenger ferry “Prinsesse Ragnhild” (PR). The vessel was situated outside Gothenburg in Swedish waters.

2.2.2 Description of the event

PR sails between Kiel and Oslo. The fire on board was first discovered at approximately 01.55 hours when the alarm sounded and the engineer on duty entered the engine room and ascertained flames by the cylinder on the inside of the starboard main engine.

The course of events on board the vessel according to the inquiry is, in short, as follows (Table 2.1):

Table 2.1 – Course of events on the Prinsesse Ragnhild

Time (hrs)	Brief description
01.55	Fire in engine room reported
02.14	Mayday. Emergency call on VHF 16. Response from Farsund Radio in Norway immediately followed by response from Sweden Rescue, MRCC-Gothenburg in Sweden.
02.20	Preparation of lifeboats, rafts etc.
02.40	Decision made to apply CO_2 system. System malfunctions.
02.46	Decision made to evacuate passengers.
02.54	Signal to passengers to muster at assembly stations.
02.59	Evacuation of passengers commences.
03.25	CO_2 system is now functioning.
04.15	Fire is under control.
04.15	All evacuated apart from 6 passengers and the crew.
05.17	Fire is extinguished.

At 02.13 hrs, according to the SAR[8]-log and at 02.14 hrs, according to the Maritime Enquiry - the Captain is informed of the situation and a mayday distress message is transmitted on VHF channel 16. The Mayday is first answered by Farsund Radio in Norway and shortly after, as soon as there is a chance to break in to the radio traffic, Sweden Rescue i.e. Maritime Rescue Co-ordination Centre (MRCC) Gothenburg responds to the Mayday and takes charge of the SAR-mission as the incident has occurred within the Swedish SAR region. The position is given as N 57.39 and E 11.19.

The decision to evacuate was made due to the strong development of heat and problems in extinguishing the fire. The captain requested assistance from land.

The weather conditions during the entire SAR-mission was very favourable with good visibility. The air temperature was approximately + 18 degrees Celsius.

The Sar Mission Co-ordinator (SMC) judged the situation “Critical” and classed the case as “Distress”.

The SMC made his General Decision (GD) at 02.15 hrs, which according to the SAR-log read: “Relay distress message. Let MRSC (Maritime Rescue Sub Centre) receive and organise response – acknowledgements from merchant vessels in the area on VHF channel 67. Alert all available SAR air- and surface-units.”

At 02.16 hrs MRCC requested the assistance from Aeronautical Rescue Co-ordination Centre (ARCC) Sweden. At 02.17 hrs SSRS (Swedish Life-boat Association) stations in Käringön, Rörö and Hovås were alerted via selective-calls on VHF, and the mayday message was relayed according to the previously mentioned GD.

At the same time RCC Stavanger (Norway) offer their assistance as “supporting RCC” to MRCC Sweden.

At 02.20 hrs a Support-Group is called in to MRCC Sweden according to an alert list.

At 02.23 hrs off-duty MRCC staff-members are called in.

[8] SAR stands for Search And Rescue.

MRSC Stockholm is given the task of co-ordinating the merchant vessels responding to the distress alert.

SOK (Sörvärnets Operativa Kommando – the Danish MRCC) inform the MRCC at 02.19 hrs that they intend to send 4 surface rescue-units to the area. At the same time the SSRS vessels PO Hansson and Märta Collin report that they are now leaving port for the area. Shortly afterwards the SSRS vessel Ulla Rinman reports similarly. These units arrive at the m/s Prinsesse Ragnhild at 03.05 hrs according to the SAR-log.

Initially ARCC Sweden alerts the Säve Helicopter Base (Gothenburg) and one medical team on their minicall at 02.25 hrs.

At 02.29 hrs a FRT (Fire Response Team) from the Gothenburg Fire Brigade is alerted and leaves for Säve Helicopter Base for further transport to the m/s Prinsesse Ragnhild.

At 02.47 hrs the helicopter bases in Ronneby (Southeast Coast of Sweden) and Berga (Stockholm), as well as the Fire Response Teams in Stockholm and Helsingborg are alerted.

At 02.36 hrs clearance was given verbally for 3 Norwegian helicopters to enter Swedish territory and assist in accordance with the Swedish permission regulations.

At 02.45 hrs RCC Stavanger alerted, on request from MRCC Sweden, a Fire Response Team in Larvik to be transported to the scene in a Norwegian helicopter at 03.40 hrs.

At 02.50 hrs Swedish Coastguard vessel # 288 arrives as first vessel on the scene to the m/s Prinsesse Ragnhild, followed shortly after by the faster of the SSRS vessels. Additional vessels from SSRS, the Swedish Maritime Administration, the Swedish Coastguard and the Swedish Defence Force followed.

11 merchant vessels including 5 passenger-ferries offer their assistance in the SAR mission.

The main task for the smaller surface units in the SAR mission consisted of towing approximately 50 liferafts and lifeboats with evacuated passengers from ms Prinsesse Ragnhild to other merchant vessels where the passengers were taken care of.

The ms (motor ship) Stena Danica took 614 passengers, ms Kihlstraum 155, ms Black Watch 364 and the fishing vessel Matilda 25 passengers, making a total of 1.158.

The evacuated passengers that were taken care of onboard the above mentioned vessels, except Matilda, were later transferred to Älvsnabben no. 4 and Älvsnabben no. 5, two smaller passenger ferries servicing the Gothenburg archipelago and owned by the Styrsö Ferryboat Company (Styrsöbolaget), as well as certain other smaller vessels for further transport to the NCW (Naval Command West – a military camp) which served as assembly point for the evacuated passengers. The fishing vessel Matilda also took its passengers to Tångudden in the NCW grounds.

Helicopters also participated to a certain extent in the transportation of passengers from ms Stena Danica to the assembly point. This was later criticised seeing as these passengers were already safe onboard Stena Danica.

3 passengers were flown by helicopter directly to hospital.

At 04.15 hrs, two hours after the initial distress call and one hour sixteen minutes after the evacuation started, ms Prinsesse Ragnhild announced that all passengers except 4 (later to be corrected to 6) and the crew had been evacuated. They also informed that the fire now had been extinguished.

The favourable weather conditions as well as professional conduct of all ships crews involved contributed greatly to the successful evacuation of the passengers from the ms

Prinsesse Ragnhild, the relatively smooth transportation of these to the participating merchant vessels and the successful gathering of the liferafts. Given different conditions at another time of year, with strong winds and rough seas, the operation would have had great difficulties to succeed if the Captain had made the same decision to evacuate in the same way.

In the Maritime Enquiry at the Gothenburg District Court the Captain was asked if he would have decided to evacuate his ship in the same manner under worse weather conditions i.e. colder temperature, stronger winds and rougher sea.

The Captain replied that under the same circumstances, with the information he held that the fire was worsening and that the heat was spreading in the vessel, along with his knowledge of the resistance times of the isolation material used onboard, he would have made the same decision to evacuate, even under more severe weather conditions.

At 06.04 hrs a tug was made fast to the ms Prinsesse Ragnhild with the intention to tow her to Fredrikshamn in Denmark. This destination was later changed to Gothenburg, as a result of discussions between Ship-Inspectors and the Port of Gothenburg.

At 06.16 hrs the Ship-Inspectors informed that it had been double-checked that there were no remaining passengers onboard and that the situation was under control.

At 07.47 hrs the tugs Per and Lars are made fast and start towing ms Prinsesse Ragnhild to Gothenburg Port.

At 12.55 hrs ms Prinsesse Ragnhild is alongside berth number 601.

During the evacuation Fire Response Teams from Gothenburg, Helsingborg and Stockholm were alerted at first, and somewhat later even from Norway (Larvik) and Denmark (Fredrikshamn).

Difficulties arose in putting the Fire Response Teams directly onboard the PR, and it was therefore decided to drop them of on other suitable vessels for further transportation with smaller units.

The first Fire Response Team on the scene came from Frölunda fire-station in Gothenburg and were flown out by helicopter to the ms Stena Danica and from there transported with a smaller vessel to the PR. Certain difficulties were encountered in boarding the PR.

At 04.50 hrs the first Fire Response Team from Frölunda were onboard the PR, 35 minutes after that the PR had announced that there were no longer any passengers left onboard, except for a few truck drivers that stayed onboard at their own choice.

Shortly afterwards Fire Response Teams from the Kortedala fire-station in Gothenburg, from Larvik in Norway and from Fredrikshamn in Denmark boarded.

Seeing that the PR had no “Helicopter Landing Area” these teams were all transported via other passenger ferries (Stena Danica and Queen of Scandinavia) with smaller units to the PR, at a certain time-loss. It was decided not to use the “Helicopter pick up area” available on the PR. This decision was later changed.

At 06.09 hrs it was informed that there were four Fire Response Teams onboard - one Danish, one Norwegian and two Swedish.

The Fire Response Team from Helsingborg, Sweden was transported by helicopter to Säve Helicopter Base where they arrived at 05.35 hrs, or shortly thereafter.

They then waited there together with a Fire Response Team from Stockholm as backup until 08.30 hrs when they were flown out to release the two Swedish teams and the Danish team.

The Fire Response Team from Stockholm was alerted at 02.45 hrs and left for Berga Helicopter Base for further transport by helicopter to Gothenburg. However, the first team awaited a medical team (which was not requested from MRCC), delaying their departure from Berga until 04.28 hrs.

The second team from Stockholm was cancelled at 05.04 after they first had waited at Berga and later were flown to Huddinge Hospital to collect a medical team.

The decision to await medical teams was taken by the helicopter Pilots without the SMC's knowledge at MRCC.

As mentioned, a considerable amount of helicopters were used in the mission: 8 Swedish, 3 Danish and 2 Norwegian helicopters were alerted. Subsequently, 4 Swedish helicopters were cancelled, thus only 9 helicopters were actually used in the mission.

The helicopters were mainly used to transport Fire Response Teams to amongst others, Stena Danica, seeing the PR was supposed incapable of receiving helicopters, as before mentioned.

Four persons suffering from smoke-inhalation were transported by helicopter to Östra Hospital in Gothenburg. Some helicopters also transported passengers from Stena Danica to the assembly point at NCW, which was deemed unnecessary, since the passengers already were safe onboard the passenger ferry. This fact was also confirmed in several reports following the mission.

The cause of fire has later been established as a combination of either a flexible hose on the fuel oil return pipe fracturing, alternatively failure in the connecting piece, and the fact that the oil hit a sufficiently warm surface causing ignition.

The engine was originally designed with tailormade annealed steel return pipe from the fuel pumps. The original return pipes were later replaced by mass produced pipes which often had to be forced into place. This resulted in stress in the pipe which, combined with vibrations, resulted in fatigue fracture and leakage. When cracks were discovered in these pipes, they were replaced by mass produced reinforced flexible hoses.

2.2.3 Human consequences

1167 passengers and a crew of 172 were aboard the ferry; in total 1339 persons. One person suffered heart failure during the evacuation. She was resuscitated and transported to hospital where she later died. 13 other persons were taken care of by hospital staff, but none were seriously injured.

2.2.4 Economic losses

The economic consequences of fire on board vessels is estimated to approximately 130 thousand Euro per minute.

The total amount of SAR units engaged in the mission were the following:

- SSRS: Rescue-boats Märta Collin, Po Hansson, Ulla Rinman, Dan Broström and Lars Prytz.
- Swedish Maritime Administration: Pilot-boats nos. 739, 735, 556 and 742.
- Swedish Coastguard: Coastguard vessels nos. 288, 447, 483 and 050.
- Swedish Military Forces: 3 Combat-boats (model Stridsbåt 90), 1 "Trossboat" and 1 minesweeper.
- Styrsö Ferryboat Company: "Älvsnabben" nos. 4 and 5.
- Rescue-boat Göte

- Danish Rescue-boat Samsö
- Tanker ms Tell
- Passenger-ferry ms Stena Danica
- Chemical-tanker ms Kihlstraum
- Passenger-ferry ms Black Watch
- Fishing-vessel Matilda
- Tanker ms Futura
- 8 Swedish helicopters, whereof 4 subsequently cancelled.
- 5 foreign helicopters (2 Norwegian and 3 Danish)
- Fire Response Teams from Sweden (Gothenburg, Helsingborg and Stockholm), from - Denmark (Fredrikshamn) and from Norway (Larvik).

2.2.5 Prevention measures and related lessons learnt

The shipowners are responsible for fire prevention on board the vessel. This includes necessary equipment for the crew and passengers should fire occur, and essential training and drills for the crew.

Lessons learnt

- The two main engines on board Prinsesse Ragnhild had a common feed pump for fuel. The engine which had caught fire was stopped immediately, but the other was left to run. This resulted in the continued pumping of fuel oil from the damaged hose. In addition, there was a common fuel pipe from the day tank to the auxiliary engine. The consequences of this situation would suggest that separate fuel injection to each main engine and groups of auxiliary engines should be introduced. The feed pump for each main engine/group of auxiliary engines must shut off automatically when emergency shut-down is undertaken. When pressure drops in the fuel supply system the alarm must be sounded. The automatic start up of “stand by” feed pump according to present day requirements should be reconsidered.
- Thermal oil systems should not be permitted in new passenger vessels unless the fire risk analysis shows that this is a safe solution.
- Steel pipes should be used for both fuel supply and return pipes. All fuel pipes must be fitted in such a way that they are not put into tension during installation. If flexible hoses are absolutely necessary in low pressure pipes, they should be type-approved and installed as double hoses.
- Subsequent investigations have shown that on most equivalent engines, areas are to be found which attain over 220^0C despite the fact that the engines are isolated. In the future, isolation of warm surfaces in new engines should form part of the criteria for type-approval.
- Following the fire on board Prinsesse Ragnhild, Norway has chosen to expedite the requirement for a local extinguishing system in engine rooms. At international level the requirement for local extinguishing systems in engine rooms (fixed-water local application fire fighting system for use is category A machinery spaces) comes into force 1 July 2002 pursuant to revised SOLAS 2000. The requirement will be applicable to vessels with an engine room size of more than 500 m^3. This requirement was introduced for Norwegian passenger vessels in international service with effect from 1 January 2001, and from 1 July 2001 for vessels in national service.

- As written above, the economic consequences of fire on board vessels is estimated to approximately 130 thousand Euro per minute. As the cost of a local extinguishing system is the equivalent of 1 minute's fire on board, it is advantageous to make such an investment. Furthermore, the average time for the CO_2 system to trigger off in connection with fire in engine rooms is 20-30 minutes from the outbreak of fire. 63 % of fires on board vessels break out in the engine room.

2.2.6 Preparedness measures and related lessons learnt

Shipowners who operate vessels in fixed or regular routes must have emergency contingency plans for company and vessel drawn up in agreement with the national rescue services in the countries involved. The vessel's emergency plans shall safeguard passengers, crew, the environment and cargo, and contribute to reducing the extent of any possible damage.

The vessel's crew must be capable of extinguishing any conceivable fire in an efficient manner. Land-based assistance must only be regarded as a supplimentary resource which may be recruited. In 1993, Norwegian Municipal Fire Services were given a general instruction to render assistance in cases of fire and other accident situations in sea areas in or outside the territorial water limits.

Lessons learnt

- Naturally, the transportation of fire fighters from land to vessel takes time. The fire on Prinsesse Ragnhild stresses the need on board for sufficient equipment and competence. Land-based fire fighters shall be regarded as welcome assistance in attaining optimal effect over a comparatively long period of time. In addition, any likely positive psychological effects on crew members comes into consideration. The fire was already extinguished on Prinsesse Ragnhild when the land-based fire fighters were ready to contribute. They were therefore engaged to cool down heated areas and undertake post-fire extinguishing where necessary.

2.2.7 Response actions and related lessons learnt

When fire occurs on passenger vessels it is essential that people vacate their cabins quickly and arrive at assembly stations for evacuation. The evacuation of passengers on Prinsesse Ragnhild was successful. Limited smoke came into passenger quarters and the situation could have been more difficult if there had been greater amounts. Traditional smoke diving equipment is intended for fire fighting personnel and is not well suited for crew members whose duty is to assist passengers.

Good internal communication from the crew to passengers over the PA (Public Address)-system is essential. One of the communication centres in the engine room was not functioning during the fire. This made communication more difficult during fire fighting. The decision to evacuate passengers was taken, but continued fire fighting was necessary. The instruction to evacuate was therefore given over the megaphone to ensure that fire fighting crew remained behind.

Lessons learnt

- Crew members who are to assist passengers in an emergency situation must wear distinctive markers to ensure complete understanding as to who is responsible. They should also be equipped with suitable breathing equipment.

- Traditional life jackets proved to be difficult to work with for the crew during the incident, even though they fulfilled regulation requirements.
- The number of childrens' life jackets on Prinsesse Ragnhild was insufficient. Requirements in regulations that at least 10% of life jackets on board should be for children was, however, met with. Infants' life jackets were not available (this is not presently a mandatory requirement.) During the next two years Norway will, however, be engaged in promoting such a requirement for IMO (International Maritime Organization).
- The PA system and internal UHF (Ultra High Frequency) system should be duplicated and separated in such a manner that total communication with crew and passengers in all parts of the ship is maintained during and following fires or when taking in water. All systems should be connected to UPS (Uninterrupted Power Supply).
- Preparations should be made for the introduction of alternative channels of communication in the event of emergencies, and training in the use of these systems. Crew members who work in noisy surroundings, or work with their hands, must be issued with hands-free communication equipment.
- The possibility of constructing and placing a PA system which functions better, and which can be heard over the back ground noise of evacuation situations, should be looked into.

2.2.8 Information supplied to the public and related lessons learnt

Prior to the event

Following the fire on board Scandinavian Star in 1990, heavy focus was held on fire prevention measures on board passenger ferries. Municipal Fire Services are under general instruction to render assistance in cases of fire and other accident situations in sea areas in or outside Norwegian territorial water limits.

During the event

Two press releases were issued containing general and objective information on the incident.

Following the event

An enquiry commission consisting of experts appointed by the Norwegian Director General of Shipping and Navigation investigated the incident. The report is available from the Norwegian Maritime Directorate.

The Swedish Directorate of Shipping and Navigation has also issued a report on this incident. The report may be obtained from the Swedish directorate.

2.2.9 Recommendations to be considered in new routines within the Swedish Maritime Organisation

The Swedish Investigation, evaluation and experience of SAR case no. 529, the fire onboard the passenger ferry m/s Prinsesse Ragnhild, resultrd in the following 28 recommendations:

Recommendations regarding the management and staff-methodology at MRCC Gothenburg

- The competence and possibilities of co-operation within the LCK[9] as a whole, as well as the separate functions individually should be further looked into.
- Staff-exercises with the purpose of training and improving staff-methodology and to create routines for forming working-teams. (In accordance with the CT decision 1/98)
- All SMC's (Sar Mission Co-ordinator) shall be trained in handling major SAR-missions and, if necessary, made aware of the specific issues concerning missions of this magnitude.

Recommendations concerning the MRSC-function

- Routines shall be established so that the MRSC-function can be activated in the best possible way in major SAR-missions. The MRSC is a part of the MRCC staff and shall be utilised efficiently.

This recommendation should be co-ordinated with the recommendations concerning the MRCC.

Recommendations concerning observations from Norway and Denmark

- In international SAR-exercises or exercises of an international character, the English language shall be used.
- The issue of satisfactory communication-equipment for Fire Response Teams shall be discussed further within the Fire Response Team Co-ordination Group. (See recommendations concerning Fire Response Team)

Recommendations concerning communication

- In major SAR-missions where a large amount of SRUs (Search and Rescue Units) and an OSC (On-Scene Commander) are involved as well as in major SAR-exercises, the SMC shall, if required, designate a working frequency for communication between SRUs and OSC.
- The effects of distributing separate frequencies to air- and surface-units involved in SAR-missions should be further investigated and evaluated.
- Further recommendations concerning communication are listed under "Recommendations concerning Fire Response Teams" and "Recommendations concerning observations from Norway and Denmark".

Recommendations to improve the Support-Group function.

- Specific tasks and routines for the Support-Group are to be established in connection with the implementation of the recommendations concerning the MRCC and MRSC functions.

[9] LCK – LedningsCentralen Kärringberget. The LCK is a combined co-ordination center consisting of four separate authorities, The MRCC (Maritime Rescue Co-ordination Centre), the ARCC (Aeronautical Rescue Co-ordination Centre), the Swedish Coastguard District West and the Military Sea-surveillance West.

Recommendations concerning guidelines for Captains/Shipping Companies in connection with SAR-missions.

- Guidelines specifying the Captains obligations and conditions of responsibility, when requested to participate in SAR-missions by MRCC, in accordance with the Ship Safety Act, The Maritime Law and the Swedish Rescue Services Act shall be established. The guidelines shall be worked out in co-operation with the Maritime Inspection, the Legal Department and the Maritime Traffic Department of the Swedish Maritime Administration.

Recommendations concerning Fire Response Teams.

- The SMC at MRCC is to decide which resources are to accompany the helicopters used in a SAR-mission. (According to the agreement established between the Swedish Maritime Administration and the Swedish Military Forces.) The helicopter-crew shall not take onboard and transport any additional personnel besides the crew without prior consultation and clearance from the SMC Sar Mission Co-ordinator).
- In case uncertainty arises as to who is to decide where to tow a disabled vessel during the course of a SAR-mission, procedures should be drawn up stating channels of contact and responsibilities of decision between the Shipping Company, the Maritime Inspection, the SMC and Port Authorities.
- In one mission-report the question of neighbouring countries Fire Response Teams organisation is mentioned.

  At a NORDRED[10] conference in Kuopio, Finland in 1996, the issue of a Nordic Fire Response Team collaboration was discussed within a working-group, which resulted in recommendations for the continuation of this co-operation. The issue has also been discussed in the Swedish Fire Response Team Co-ordination Group. The Swedish Rescue-Service Administration has been suggested to bring up the issue with our neighbouring countries within NORDRED to further develop methodology and instructions.
- The proximity of a Fire Response Team station and/or of a helicopter base with SAR-readiness should be taken into consideration, when deciding on the use of a Fire Response Team in a SAR-mission. In the case of m/s Prinsesse Ragnhild it took 2 hours and 20 minutes before the Fire Response Team was onboard the disabled vessel, despite the nearness to both a Fire Response Team station and a helicopter base with SAR-readiness, which must be considered remarkable. This fact requires further attention and investigation.
- In the instructions for the Fire Response Teams, established in co-operation between all Fire Response Team stations, means of communication and frequencies have been designated for the purpose of communication between Teams. As the communication failed in this SAR-mission this issue should be further discussed within the Swedish Fire Response Team Co-ordination Group.
- There must be no question for the Fire Response Team on the purpose of the mission or on where the responsibility of the mission lies. In this case there was uncertainty over whether the Fire Response Teams were involved in life-saving or salvage of property. If the primary task is to save lives, it must be clearly notified by the SMC

[10] NORDRED – A Scandinavian Committee of experts involved in Rescue Services in general.

when this task is considered to be over. Information/instructions regarding this aspect shall be established for the SMC as well as for the Fire Response Teams.

Recommendations concerning the OSC function

- The co-operation between the SMC (Sar Mission Co-ordinator) and the OSC (On-Scene Commander)-Pilots shall be subject to further practice and improved to eliminate misunderstandings on the responsibilities and tasks of the parties when an OSC is involved in a SAR-mission.
- The OSC-Pilots shall be informed, instructed and trained in co-operating with an ACO-function.
- The OSC-Pilots should be informed on the importance of choosing the most suitable SRU to be used as "platform" for the OSC-function.

Recommendations on the use of helicopters involved in SAR-missions.

- Helicopter-crews, the medical organisations and responsible authorities shall be informed of the fact that it is the SMC, in accordance with the Swedish Rescue Services Act, who decides which personnel and equipment is to be taken in the helicopters used in a SAR-mission. (See recommendations concerning Fire Response Team).
- The ACO (Aircraft Co-ordinator)-function shall be improved and the co-operation between SMC, ACO and OSC practised.
- Helicopters engaged in a SAR-mission, but without a specific task, shall not be airborne on the scene, but should rather, when practically possible, be landed in the vicinity. Information/instructions regarding this matter should be established within the improvement of the ACO-function.

Recommendations concerning the Assembly Point

- Considering the problems encountered with identification and keeping count of the passengers involved in major SAR-missions, the SMC should, as far as possible, avoid establishing more than one assembly point.

Recommendation regarding media-relations in SAR-missions

- Routines for media-relations in connection with SAR-missions are to be established by the Department of Public Relations at the Swedish Maritime Administration.

Recommendation regarding the choice of berth for a hazardous disabled-vessel

- In major SAR-exercises this aspect should be considered and practised.
- Contacts with other ports in the area should be made at an early stage.

Recommendation concerning medical assistance in SAR-missions

- Plain instructions shall be made out for the SMC, the Medical Authorities and other authorities and organisations involved in SAR-organisation, regarding the participation of medical teams in SAR-missions. It should furthermore be controlled that these directives are subsequently followed.

2.3 The Ulsund-LHNW Disaster (Norway, Finland)

Finn Paulsrud *(Maritime Investigator, Norway)**,*** ***Martti Heikkilä,*** *(Accident Investigation Board, Finland),* ***Risto Repo*** *(Accident Investigation Board, Finland)* and ***Jerker Klaweri*** *(Finnish Maritime Administration, Finland)*

This contribution is based on the Joint Norwegian/Finnish Marine Casualty Report (May 2001) downloaded from http://www.onnettomuustutkinta.fi/10889.htm.

2.3.1 Date of the disaster and location

27 February 1998, in the waters off Lista, Norway.

2.3.2 Description of the event

The Ulsund (see Fig 2.3.a) loaded 2,404 metric tons of aluminium in St. Petersburg, Russia in the period from 14 February to 17 February 1998. The ship sailed from St. Petersburg on 17 February 1998 at 19.15 hrs, heading for Høyanger, Norway. There was ice in the innermost part of the Bay of Finland and the ship had to wait for about two and a half days for icebreaker assistance. The ship arrived at Copenhagen in the morning of 25 February 1998 after being slightly delayed in the Baltic Sea due to bad weather. The captain was replaced in Copenhagen. The cargo and the excavator were checked and found to be in order and bunker oil, fresh water and provisions were brought on board.

Figure 2.3.a– The MV Ulsund.
© Accident Investigation Board Finland

In the afternoon of 25 February 1998, the voyage to Høyanger continued. In the Skagerrak, the ship encountered SW/W winds, varying between near gale and gale, and heavy sea, 5 to 6 m. The ship's speed was reduced to 3 to 4 knots. The master called the shipping company in Finland both on 26 February and on 27 February 1998 without giving any information about problems related to the seaworthiness of the ship. On 27 February 1998 at 21.25 hrs the ship transmitted the distress alert MAYDAY on VHF radio channel 16 from the position N 57.00-57.80 and E 06.00-12.60 (see Figure 2.3.b) Farsund Radio answered the ship immediately and after roughly 70 seconds the captain told them that:

a) the ship made water,
b) its port bulwark and deck were submerged,
c) it listed approx. 6 degrees (to port),
d) they were trying to pump,
e) they needed immediate assistance,
f) there were 7 people on board.

It is assumed that the ship went down in the course of about 10 to 15 minutes, as no other vessel observed any clear radar echo in the indicated casualty position. The first vessel reached the indicated casualty position about one hour later, at which time there was only wreckage left.

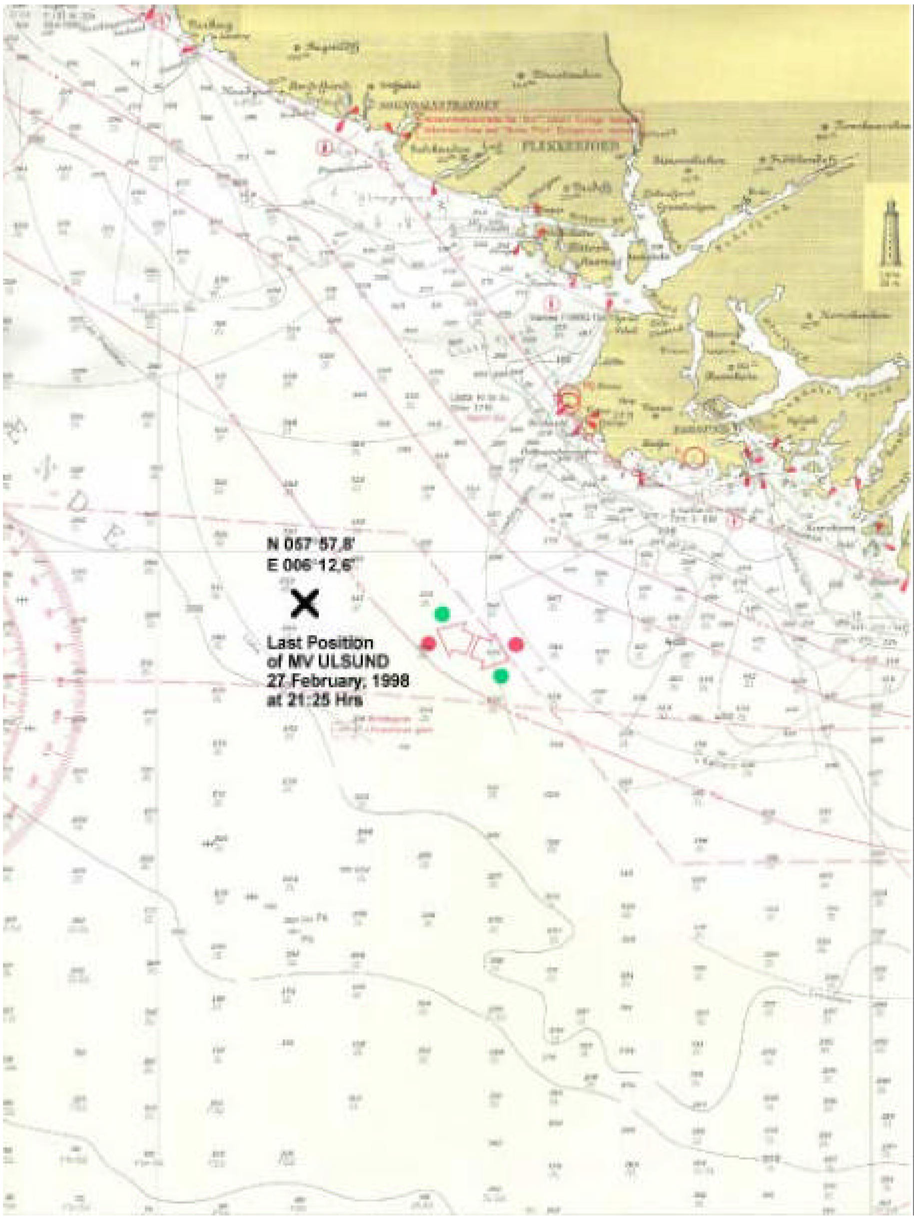

Figure 2.3.b– Last position of MV Ulsund.
© Accident Investigation Board Finland

2.3.3 Human consequences

7 people (entire crew) lost their lives in this disaster.

2.3.4 Economic losses

Not available.

2.3.5 General findings and related lessons learnt

Related to the excavator and transverse beam

In accordance with the test certificate for excavator/traverse beam, the placement of equipment when the ship was underway was as that during voyage the transverse beam should be parked on aft end of cargo hatch and locked" .

According to information from ship owner Trond Kittilsen, the excavator/traverse beam could either be secured at the front end of the wheelhouse or at the aft end of the forecastle. There were two steel brackets for securing the traverse beam at the front end of the wheelhouse, where these steel brackets were welded to the starboard and port rails of the hatch covers. Similarly, two steel brackets for securing the traverse beam at the aft end of the forecastle were welded to the starboard and port rails of the hatch covers. In each of these four steel brackets, there was a hole, enabling one to lock the traverse beam by inserting a steel bolt with a diameter of 100 millimetres.

Video recordings of the Ulsund wreck in the summer of 1999 show that none of the steel brackets on the rails where the traverse beam could be locked with steel bolts were deformed/damaged, neither those at the aft end of the loading hatch nor those in front. Since none of the four steel brackets, which are arranged and devised for fastening the traverse beam, have been deformed/damaged, this proves that the excavator/traverse beam cannot have been parked and locked as was required of the equipment, i.e. "parked on aft end of cargo hatch and locked".

- It is necessary that investigators address to all parties concerned, i.e. dockyards, planners, shipowners, operators, masters and classification societies that, the excavator and its traverse and other heavy cargo-handling equipment must be arranged and secured as indicated in documents for such equipment when the vessel is under way.

Related to water ingress and leakages

When questioned, some of the crews that sailed on the ship in the autumn of 1997 and the winter of 1998 explained that on some occasions water had leaked into the hold and the double bottom tanks.

In his distress signal made at 21.25 hrs on 27 February 1998, the ship's captain stated that:

- The ship was making water, without stating where.
- Attempts were made at pumping, without stating from where.
- The ship's port-side railings and deck were under water, and the vessel had a six degree list.
- The ship disappeared from the surface of the sea in a short space of time, an estimated 10–15 minutes.

On the basis of the above distress signal, and the brief period of time before the ship disappeared from the surface of the sea, the ship must have taken in large amounts of water within a relatively short period of time. It is highly probable that water has leaked into the hold. No other tanks or containers have a volume large enough to cause the ship to sink by the leaking of water in such as short space of time. Since the ship had a list and the deck was under water, the ship's stability was reduced dramatically.

The cause of the water penetration is unknown, there are two matters that may have led to this, i.e.:

1. Due to the bad weather, the excavator/traverse beam, weighing a total of approx. 45 tonnes, may have come loose and damaged, or even removed, the hatch covers with, for example, the excavator arm or the grab. In the bad weather, with W-NW winds of 30 knots and a significant wave height of 5-6 m, vast amounts of seawater may have entered the hold.

   From video recordings of the wreck in the summer of 1999, it may be concluded that the excavator/traverse beam was not locked as described in the certificate for the above-mentioned equipment, i.e. that the traverse beam was not locked by inserting steel bolts into the brackets at the aft end of the loading hatch, since none of the steel brackets were deformed or damaged.

   The steel brackets at the front end of the loading hatch are not deformed or damaged, which would indicate that the excavator/traverse beam was not locked to the aft end of the forecastle either.

   However, there are remains of the mooring lines and wire approximately amidships on the main deck, perhaps indicating that the crew could have used this to fasten "something". It is natural to believe that mooring line and wire have been used to lash/lock the excavator/traverse beam, which has stood in a position approximately midway over the loading hatch, most likely with the grab resting on the hatch cover.
2. The crew members who sailed on the ship in the autumn of 1997 and the winter of 1998 have stated of the occasional leaking of water into the double bottom tanks and occasionally into the hold. Such leaks could also have occurred on the casualty voyage, which has meant that the ship had little freeboard, and would thus be subjected to enormous stress on its hull, particularly on the bow. In the bad weather, with a significant wave height of 5-6 m, cracks may have formed in the bow section, resulting in large amounts of water leaking into, among other things, the hold, thus causing the casualty.

- It is important that investigators deal seriously with water ingress and leakages. If there is water ingress in a vessel, for instance to tanks or holds, such problems must be resolved before the ship puts out to sea.

2.3.6 Information supply to the public and related lessons learnt

Not available.

2.4 The Lea and Nipsu Disaster

Risto Repo *(Accident Investigation Board Finland, Helsinki)*

2.4.1 Date of the disaster and location

12 April 1999, in the waters of the southern Bay of Bothnia.

2.4.2 Description of the event

Baltic herring trawlers Lea and Nipsu were trawling in the southern Bay of Bothnia. The fishermen did not arrive to their port at the time they had reported. The search and rescue on the next morning resulted in the finding the trawler, Nipsu but not Lea.It was at sea in full condition, with the engine running and lights on but nobody onboard. The vessels had been working as pair trawlers, both manned with one fisherman. It is a practice to leave the other vessel drifting and then the other fisherman moves to the vessel, which will take the catch. It was obvious that the other trawler had sunk.

Investigation showed that the accident occurred when hoisting the load of fish onboard. The vessel lost it's stability, listed and caught water on deck in stern area. This resulted in increasing loss of stability and the vessel sunk rapidly.

2.4.3 Human consequences

There were two deaths (one from each trawler). In June 1999 local fishermen organised a search and found a wreck which was later identified to be the missing trawler LEA.

Later in summer 1999 the other fisherman was found dead in water in the archipelago of Kristiinankaupunki. The other fisherman has not been found.

2.4.4 Economic losses

Not available.

2.4.5 General findings and related lessons learnt

- It is essential that for the smaller fishing craft, which have been built without drawings and stability calculations should dealt with in a special manner, i.e. these stability criteria should be evaluated with practical tests and there should be a nomination of the maximum load of fish to be hoisted per heave.
- Education and training should be provided (practical with examples and theoretical) for the masters of fishing vessels.
- The maritime authorities should demand the necessary stability information also from the smaller fishing vessels, and also a load line or maximum cargo (fish) amount should be established for each individual fishing vessel. This is possible within existing legislation framework in Finland.
- The effect on safety of fishing depends strongly on the fishing method and on the quality and condition of the fishing gear. Therefore it is important that these should also be checked during the inspections by the authority.
- It is important to wear suitable life jackets, which do keep an unconscious person in upright position.
- The assisting vessel should be manned all times.
- Fishing vessels should have automatically releasing life rafts with a drift anchor.

2.4.6 Information supply to the public and related lessons learnt

Not available.

3 RECAP OF LESSONS LEARNT

Ana Lisa Vetere Arellano
(EC, Joint Research Centre, Ispra)

The contributions in this report document that maritime disasters are also quite common in Europe (see Annex A for other examples of maritime disasters) and that their causes vary (see Annex A for the possible causes).

It is obvious that lessons learnt from maritime disasters is accident specific. Each disaster will have its characteristics and, depending on the country in which the disaster has occurred, it will also have a different disaster management scheme. This chapter aims to summarise general lessons learnt that have been retrieved from the four maritime disasters described in this report, which have been grouped according to the disaster management phase (prevention, preparedness and response). Furthermore, where relevant, the lessons learnt have been grouped into the following areas:

- Regarding regulation
- Regarding coordination
- Regarding inspectors
- Regarding training
- Regarding equipment and maritime vessel
- Regarding communication.

Lastly, lessons learnt regarding the dissemination of information are also summarised.

It is important to bear in mind that the lessons learnt are not ordered according to their importance, but mainly according to “logical” considerations.

3.1 Lessons learnt concerning prevention measures

Regarding regulation

- The SOLAS requirements should always be satisfied.
- Design procedures for bow doors should be continuously improved, in line with new technologies.
- Guidelines specifying the Captains obligations and conditions of responsibility, when requested to participate in SAR-missions should be established, in accordance with any existing legislation. The guidelines shall be worked out in co-operation with all competent authorities.
- The ship owners should be made responsible for fire prevention on board the vessel.
- The maritime authorities should demand the necessary stability information also from the smaller fishing vessels.
- A load line or maximum cargo (fish) amount should be established for each individual fishing vessel.

Regarding investigators

- It is necessary that investigators address to all parties concerned, i.e. dockyards, planners, ship owners, operators, masters and classification societies that all heavy cargo-handling equipment must be arranged and secured as indicated in documents for such equipment when the vessel is under way.

- It is important that investigators deal seriously with water ingress and leakages. If there is water ingress in a vessel, for instance to tanks or holds, such problems must be resolved before the ship puts out to sea.
- The effect on safety of fishing depends strongly on the fishing method and on the quality and condition of the fishing gear. Therefore it is important that these should also be checked during the inspections by the authority.

Regarding equipment and maritime vessel

- When a fire occurs, it is necessary that adequate equipment for the crew and passengers are readily available.
- It is important to wear suitable life jackets, which do keep an unconscious person in upright position.
- Fishing vessels should have automatically releasing life rafts with a drift anchor.

Regarding training

- Essential training and drills for the crew must be promoted and ensured.

3.2 Lessons learnt concerning preparedness measures

Regarding coordination

- The competence and possibilities of co-operation within the coordination centre as a whole, as well as the separate and individual functions should be further looked into and well identified and established.

Regarding training

- The crew should have been better prepared for crisis situations, in order to react more efficiently.
- Evacuation manoeuvres should be regularly practiced and carried out during crisis situations.
- Staff-exercises with the purpose of training and improving staff-methodology and to create routines for forming working-teams should be promoted.
- All SMC's (SAR Mission Co-ordinator) shall be trained in handling major SAR-missions and, if necessary, made aware of the specific issues concerning missions of this magnitude.

Regarding equipment and maritime vessel

- There is a need for sufficient on board equipment and competence at all times.

Regarding communication

- In international SAR-exercises or exercises of an international character, the English language shall be used.

3.3 Lessons learnt concerning response measures

Regarding coordination

- The coordination of the response operations should be improved, as it is necessary to respond timely to the disaster.
- It is necessary to establish which resources are to accompany the helicopters used in a SAR-mission.
- The helicopter-crew shall not take onboard and transport any additional personnel besides the crew without prior consultation and clearance from the SMC (SAR Mission Co-ordinator).
- In case uncertainty arises as to who is to decide where to tow a disabled vessel during the course of a SAR-mission, procedures should be drawn up stating channels of contact and responsibilities of decision between the Shipping Company, the Maritime Inspection, the SMC and Port Authorities.
- The proximity of a Fire Response Team station and/or of a helicopter base with SAR-readiness should be taken into consideration, when deciding on the use of a Fire Response Team in a SAR-mission.
- The purpose of the mission and where the responsibility of the mission lies must always be clear to all stakeholders. This way, e.g. there will be no uncertainty over which Fire Response Teams are in charge of life saving and those responsible for salvaging of property. If the primary task is to save lives, the SMC must be clearly notified when this task is considered to be over. Information/instructions regarding this aspect should be established for the SMC as well as for the Fire Response Teams.
- Helicopters engaged in a SAR-mission, but without a specific task, shall not be airborne on the scene, but should rather, when practically possible, be landed in the vicinity.
- Considering the problems encountered with identification and keeping count of the passengers involved in major SAR-missions, the SMC should, as far as possible, avoid establishing more than one assembly point.
- Contacts with other ports in the area should be made at an early stage.
- Plain instructions shall be made out for the SMC, the Medical Authorities and other authorities and organisations involved in SAR-organisation, regarding the participation of medical teams in SAR-missions. It should furthermore be controlled that these be followed.

Regarding equipment and maritime vessel

- The helicopters had a key part in the rescue operation by rescuing most of the people who had succeeded in climbing onto life rafts or lifeboats. However they should be better organised.
- The lifesaving equipment of vessels participating in rescue operations should be made suitable for rescuing people from the water during heavy weather conditions.

Regarding communication

- Instructions regarding distress traffic given by any coordination centre should be clearer and more precise.
- In major SAR-missions where a large amount of SRUs (Search and Rescue Units) and an OSC (On-Scene Commander) are involved as well as in major SAR-exercises, the SMC (SAR Mission Co-ordinator) shall, if required, designate a working frequency for communication between SRUs and OSC.
- It is important that the means of communication and frequencies have to be better designated for the purpose of communication between the Fire Response Teams.
- The effects of distributing separate frequencies to air- and surface-units involved in SAR-missions should be further investigated and evaluated.

3.4 Lessons learnt concerning dissemination of information to the public

- Passengers should be given targeted information so that they can be prepared for a crisis situation. Information given to passengers during a disaster should be clear and in simple language.
- Alarm should be timely and efficient.
- Routines for media-relations in connection with SAR-missions are to be established by the public relations department within the designated competent authority.

3.5 Closing considerations

International investigation into marine accidents has shown that some 80% of all maritime mishaps, accidents and disasters are caused by human failure or even crew's negligence[11]. Results of another study, which analysed total loss accidents for 15 countries with sample sizes of 500 and 1,500 ships of over 500grt[12] (Gross Register Tonne), over a period of 25 years, the first leading circumstances of maritime casualties in the merchant fleet for both sample sizes were in the following order: *stranding*; *fire*; *water leaks*; *gales*; and *collisions*.

In order to cope with such accidents, it is essential to put safety top on the priority list of all stakeholders dealing with maritime disaster management. Ship safety, and thus, the safety of its passengers, crew and cargo, are determined by internal and external factors, but most of all by human factors. Examples of these factors are given in Table 3.5.a.

Table 3.5.a – Examples of internal, external anf human factors that determine safety in navigation.

Internal Factors	*External Factors*	*Human Factors*
Ship characteristics: weight, geometry, etc.	Weather: foggy, severe storm, etc.	Degree of training of captain and crew
Ship accessories: rudder, navigational instruments, etc.	Water body characteristics: wave amplitude, currents, etc.	Awareness information disseminated to passengers

[11] Source: http://home.planet.nl/~kluijven/safety.html

[12] The grt of a ship is a measurement of the total capacity of the ship and is not a measure of weight.
Net register tonnage = (grt) – (space used for accommodation, machinery, engine area and fuel storage)
This is how the cargo-carrying ability of a ship is calculated.

This fact has clearly been echoed by the four maritime accidents portrayed in ths report. The safety of the vessel and its passengers was put at risk due to human factors and a mixture of internal and external factors. External factors cannot be controlled. They can only be monitored by internal and human factors. Thus, it is of great importance to raise awareness of the need to efficiently control these two factors.

The international treaty that has been catered to address the issue of controlling internal and human factors with regards to navigation safety, in a guided and concerted manner, is the SOLAS Convention. The main objective of the SOLAS Convention is to specify minimum standards for the construction, equipment and operation of ships, compatible with their safety. Safety can be achieved by efficient shipbuilding, fire-resistant bulkheads, life-saving appliances and facilities, radio communications, regulations regarding grain in bulk and dangerous goods transportation. SOLAS also enforces sea-time training on board merchant vessels, along with fire and abandon-ship drills.

As technology progresses and mankind increases its knowledge in maritime disaster managment, it is crucial that the SOLAS Convention evolves in simbiosis with technology advancement. Captain and crew should be well trained in the use of new navigational and communication instruments and passengers should always be updated with the latest preparedness information regarding maritime safety. Furthermore, it is fundamental that lessons learnt reports, such as this one, are fed back into the SOLAS mechanism, triggering amendments where required. Lessons learnt reports should also be catered to target all stakeholders and disseminated to as many people as possible. This would lead to increasing awareness at all levels. This way, mankind will succeed in its endeavour to guarantee the safety of life at sea.

Annex
Possible causes of maritime disasters and interesting links on maritime-related issues

Table A1 - Possible causes of maritime disasters

Bad weather
Collission (with marine animal, e.g. whale; an object, e.g. vessel, reef)
Flammable cargo
Ice
Inadequate maintenance
Inexperienced crew
Leakage
Malfunctioning of communications equipment
Miscommunication (intership, intra-ship and between vessels and Vessel Traffic Service-stations)
Overloading of vessel
Piracy
Violation of existing regulation
War

Table A2 - Interesting links on maritime-related issues

- International Maritime Organization
  http://www.imo.org/index.htm
- Accident Investigation Board FINLAND
  http://www.onnettomuustutkinta.fi/2606.htm
- Swedish Board of Accident Investigation
  http://www.havkom.se/english.phtml
- International Maritime Fire and Rescue Information
  http://www.fire.org.uk/marine/
- International Convention for the Safety of Life at Sea (SOLAS)
  http://www.imo.org/Conventions/contents.asp?topic_id=257&doc_id=647
- International Association of Classification Societies (IACS)
- http://www.iacs.org.uk/index1.htm
- Tritec Marine Cosultants
  http://www.tritec-marine.co.uk/splash.asp
- Fisher Maritime Analytical Naval Architects
  http://www.fishermaritime.com/
- Lost Liners: Earth's once great ships
- http://library.thinkquest.org/17297/index2.htm
- Missing. Lost and wrecked ships of the world
  http://www.greatdreams.com/ships.htm