

# CHALMERS



## Research Study of Sinking Sequence of m/v ESTONIA



### WP2.1 - Review of Evidence Report No. 2 Conceivable Course of Events

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#### Technical Report

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## SUMMARY

In the year of 2005 VINNOVA announced a call for research studies on the sinking sequence of m/v ESTONIA. A consortium headed by SSPA Sweden AB was awarded one project, of which the Work Package WP2.1 – “Review of Evidence and Forming Loss Hypothesis” has constituted one of the initial tasks intended to provide a starting point for simulation and model testing work.

As the study has proceeded, it has become apparent that a compilation and evaluation of information of evidential character is essential not only to provide a starting point for the forming of loss hypothesis but also as a tool to validate or reject various scenarios derived from the model tests and simulations, thus limiting the number and facilitate an increased resolution of the permutations to be further investigated.

The results of, and conclusions made during this work and related discussions are summarized in the present document; the second report within the work package WP2.1.

The purpose of this report is to summarize the evaluation of the compiled material and furthermore, from a witness testimonies perspective, to present a conceivable “Course of Events” hypothesis, see Chpt. 3. It is not intended as a revision and hence does not replace the previously issued document, but is issued primarily as an update of the Chapter 2 of the report from 10 October 2006, including the conclusions made during the Project.

It should be noted that it is not the intention of this report to present one single “True” Course of Events, which based on the available information is not achievable, but merely to constitute a tool in the process of validating or disqualifying various scenarios.



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## **1 INTRODUCTION**

### **1.1 Background**

Following the dreadful accident 28 September 1994 when the RoPax vessel m/v ESTONIA capsized and foundered in the Baltic Sea and 853 lives were lost, the authorities of Estonia, Finland and Sweden including the Joint Accident Investigation Commission compiled and investigated evidences in terms of:

- I. Interviews of survivals and other persons of relevance to the investigation,
- II. ROV Underwater Operations when the wreck was filmed,
- III. Tracing and Recovering of the Bow Visor,
- IV. Diving Operations including a survey of the bow area and the navigation bridge.

Today the site of the wreck is classified as a sanctuary. Diving and other submarine activities in the region that could help to shed some additional light on the chain of events causing the disaster are thus not allowed. Consequently, a new sinking sequence study must be based on basically the same available factual material as back in the 1990:th.

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As the study has proceeded, it has become apparent that a compilation and evaluation of information of evidential character is essential not only to provide a starting point for the forming of loss hypothesis but also as a tool to validate or reject various scenarios derived from the model tests and simulations, thus limiting the number and facilitate an increased resolution of the permutations to be further investigated.

The results of, and conclusions made during this work and related discussions are summarized in the present document; the second report within the work package WP2.1.



## **1.2 Purpose and Objective**

The purpose of this report is to summarize the evaluation of the compiled material and furthermore, from a witness testimonies perspective, to present a conceivable “Course of Events” hypothesis, see Chpt. 3. It is not intended as a revision and hence does not replace the previously issued document, but is issued primarily as an update of the Chapter 2 of the report from 10 October 2006, including the conclusions made during the Project.

It should be noted that it is not the intention of this report to present one single “True” Course of Events, which based on the available information is not achievable, but merely to constitute a tool in the process of validating or disqualifying various scenarios.

Neither is it the intention to describe in detail the consecutive flooding of the hull, since all conclusions made within this work package are based on observations made by survivors rather than on theoretical analysis work.



## **2 REVIEW OF EVIDENCE**

### **2.1 Evidence Material**

The survey of evidence material has been based on any available information. However, the media as presented in the Reference List, see Chapter 5, can be considered as primarily sources. The rationale of the material encompasses:

- I. Interviews of survivors and other persons of relevance to the investigation,
- II. Records from Sub-sea activities such as ROV Video recordings,
- III. Available Technical Documentation of the Ship,

When compared, the many different experiences made by individuals in a disastrous situation, some of which in a state of shock, will of course differ significantly, especially with regard to the time and duration of traumatic events. This divergence becomes even more pronounced as the accident develops. However, time reference for the initiation of an accident is normally more precise and coherent; witnesses can relate to their whereabouts at the time for the initiation of an accident.

It should furthermore be noted that many of the transcripts of the survivors have been translated into Swedish and English, in some cases based on a first concept in the Estonian and Russian language translated into Finnish. In some of the transcripts it is even not clear whether the witness refers to Estonian time or to Swedish time. Moreover, must the skills and experience of the interviewed person be considered when evaluating a testimony.

Some of the witnesses have also been interrogated several times; more or less influenced by various external sources. Consequently some discrepancies can be found when comparing statements given by the same witness but at different occasions. In such a case the earliest testimony has been given the highest ranking.



## 2.2 Methodology

Following a first review of the available material a number of relevant “search items” were defined where after a second review was executed. As the project has proceeded several additional assessments of the material have been carried out, whereupon the “search items” in many cases had to be redefined. However, in general the main focus has been on the following observations:

No.	Time Period	Observation
1	At departure	Observations with regard to the lashing of cars, trucks and semi-trailers.
2	Sea voyage prior to onset of accident	Observations with regard to unusual / unexpected noise, ship performance or activities.
3	Experienced onset of accident	Observations made in conjunction with and time reference for the experienced initiation of the accident.
4	Development of floating status	Specific values, estimates or geometrical information related to the increasing list and trim, and any corresponding time references pertaining hereto.
5	Flooding of buoyant hull volumes	Observations of water ingress into the buoyant hull volumes below the freeboard deck, Dk 2.
6	Observations made on Open Deck	Observations made on open deck related to list and to Ship’s orientation towards wind and waves.
7	Observation made at evacuation	Observations made when witnesses abandon the Ship, e.g. list, trim and freeboard.
8	Observations made after evacuation	Observations from life raft related to the sinking of the vessel; stern or bow down etc.
9	Other specific observations	Other specific observations related to the accident but not in particular to the capsizing and sinking. The information sought for is used as reference, linked with Items 1-8 as specified above.

Table 1 Search Items applied in Second Assessment



## 2.3 Time Line

Within this study any event having a time reference has been linked to other significant events into a network. Some events are more distinct than others with regard to time and list references and have hence been selected as key events, to which other observations may be linked. Thus providing a data volume from which some conceivable “Course of Events” may be extracted. The following key events have been utilized:

- T0 Two, three heavy impact banging noises from the bow followed by a first permanent list to SB.
- T1 Sudden significant increase of permanent list,  $\Phi = 20-25^\circ$ .
- T2 The faint alarm “Häire, Häire”, sent out on the public announcement system by a woman in the Information.
- T3 The releasing of the WT-Sliding doors including the local ringing alarm sounded while closing.  
The alarm “Mr. Skylight No 1 and No 2”, sent out on the public announcement system by the 2:nd Mate (Watch Officer).
- T4 The failure of Main Engines, ME:s, due to loss of Lube Oil pressure,  $\Phi = 30-35^\circ$ .
- T5 The failure of Auxiliary Engines, AE:s, due to loss of Lube Oil pressure,  $\Phi = 45-50^\circ$ . Lights flicker but are re-lit when the Emergency Generator was engaged.
- T6 The failure of Emergency Generator, Emrg Gen.,  $\Phi = 80-85^\circ$ . All lights are out except for battery driven emergency lighting.
- T7 Sounding of Ship’s Whistle; the sound “drowns” when the ESTONIA is on her side,  $\Phi = 90^\circ$ .  
Ship Clock stops at 23:35 UTC,  $\Phi > 90^\circ$ .
- T8 Loss of Ship, Radar Echo gone, 01:48 hrs.

Table 2 Key Events

It should be noted that all time references within this report are given in Ship Time (= Estonian time = CET +1).



### 3 COURSE OF EVENTS

Based on the assessment of information of evidential character the following Conceivable “Course of Events” hypothesis, leading to the accident and consequently the loss of the ESTONIA can be established. It should be noted that the time references are sometimes an estimation made based on other interlinked observations.

#### **Estonian Time    Event / Observation**

1994-Sep-27  
19:00 hrs    m/v ESTONIA departs from Tallinn. The ship was carrying full deck payload. Cars were not lashed to the deck, only the car parking break and in some cases a gear constituted the securing. Some trucks and lorries were hindered from sliding by rubber chocks. Semi-trailers were lashed by four web-lashings. Heavy weather was forecasted.

Due to an alleged bad cargo stowing plan, the ESTONIA departs having an offset in transverse centre of gravity resulting in 1-2° SB list.

During the voyage when the ship is encountering full wind force the heeling angle is further increased. The inclination is to some extent compensated by means of water ballast. However, already within the first couple of hours the capacity of the heeling tank system is fully utilized and the ship continues her voyage at a list of about 2-4°.

1994-Sep-28  
00:00 hrs    The ESTONIA reaches the waypoint, the speed was 14.5 kts. After change in course, the wind was South-West veering to West and the waves were somewhat more westerly.

Following the passing of the waypoint the fin stabilizers were engaged.

Possibly due to change in course together with the influence of the fin stabilizers, a change in motion characteristics and performance is noted by some survivors, some of which fall over on the dance floor.

00:45-00:50 hrs    The ESTONIA suffers a severe wave impact. Two, three heavy banging noises are heard from the bow when the visor hinges break.

**T0**



**Estonian Time    Event / Observation**

00:50-01:05    During the labour of the visor lug plates when cutting through the F'cle Deck and the Deck Transverse at #159, the ramp housing hits the tip of the ramp. The ramp locks break under the force of the visor and the ramp falls into and rests on the upper "cross bracing" in the visor structure.

Water is pressed at the sides of the ramp and onto the Main Deck, Dk 2 as noted by the crew in the ECR. A first SB list is developed which increases as more and more water is entering the Garage on Main Deck.

01:05 hrs  
**T1**    The visor is lost and the ramp falls down on the Fore Peak deck. The ship heels over and remains at a significant SB list of about 20° making loose items to fall. Among other items one alarm clock that stopped 12:02AM when the battery fell off. Some witnesses wake up by falling off their beds.

A PS turn is initiated and the levers on the Nav. Bridge are pulled to zero.

01:07 hrs  
**T2**    The alarm "Häire, Häire" is announced from the Information Desk on Deck 5. The list is now about 25-30°.

01:08 hrs  
**T3**    In an attempt to follow the ESTONIA's Safety Manual the WT-doors are remotely released from the Nav. Bridge. Immediately thereafter the cryptic "Mr. Skylight to number One and Two" is announced from the Nav. Bridge.

A first distress call is sent out and heard on VHF channel 16 by an AB Seaman onboard a vessel in the vicinity. The call comprised only three Mayday, Mayday, Mayday, hence no identification of the Ship in distress could be made. When informing the officer in command on the bridge the AB Seaman was told that if he had heard a distress call the vessel in distress would certainly repeat the call.

01:10 hrs  
**T4**    Due to list and consequently loss of LO-pressure PS Main Engines (ME:s) tripped and stopped. Shortly after also the SB ME:s stopped. The list is close to 35°.

01:17 hrs  
**T5**    The Auxiliary Engines (AE:s) tripped and stopped and consequently the lights flicker for a second until the Emergency Genset started. The list is now exceeding 45°.



<b>Estonian Time</b>	<b>Event / Observation</b>
01:22 hrs	First officially recorded Mayday is transmitted from m/v ESTONIA. It states "Mayday, Mayday ESTONIA Please.
01:25 hrs	During the distress traffic m/v ESTONIA declares having a Black-Out.
01:27 hrs <b>T6</b>	The Emergency Generator shuts down. The list is about 80-85°
01:29 hrs	The last message in the distress traffic from m/v ESTONIA is transmitted.
01:31 hrs <b>T7</b>	The ship is on her side and an aft trim has been developed. The ship's whistle is sounded; a sound that "drowns" in the water. Many of the survivors are washed off by waves from the ship's side, the distance from the side down to the water surface is limited. A "beach line" is already present below which the after body is immersed.
01:35 hrs	The radio station clock (BHD mounted) in the chart room of the Navigation Bridge stops at 23:35 UTC.
>01:35 hrs	At some point the lowest part of the sinking ship touches-down on the seabed at a water depth of about 80m, thus most likely slowing down the sinking process. The wind and current forces the ship to pivot somewhat around the stern structure to its final orientation on the seabed.
01:48 hrs <b>T8</b>	m/v ESTONIA disappears from the radar screen at Utö Radar Station.



## 4 COMMENTS ON SIGNIFICANT OBSERVATIONS

### 4.1 The Last Voyage

In the evening of the 27 September 1994 the ESTONIA departed Tallinn close to 19:00. Following the passage out of the Port of Tallinn the Officers onboard the Ship could choose between two alternative routes through the Gulf of Finland;

- The Southern route passing South of the Island of Naissaar then following the fairway North of the Estonian Coast Line
- The Northern route passing North of the Island of Naissaar then following the fairway South of the Finnish Coast Line

The ESTONIA was known by the Finnish-Swedish ferry lines to frequently intervene with this traffic by selecting the Northern route. In spite of the heavy weather at least three survivors testified that they had visual contact with two other vessels, presumably the MARIELLA and the SILJA EUROPA. One of these witnesses states that he could identify the MARIELLA while evacuating the ESTONIA.

In addition, the 2:nd Mate (Watch Officer), E1, on the MARIELLA keeps track on the ESTONIA on the radar. He also confirms having visual contact and states that he recognizes the silhouette of the ESTONIA.

It would seem reasonable that the ESTONIA had chosen the Northern route already through the Gulf of Finland, primarily due to the fact that the Captain of the alternate crew, was onboard for his Pilot certificate examination valid for passage through the Söderarm fairway, i.e. the Northern entrance into the Stockholm archipelago, but also due to the fact that entrance into the Stockholm archipelago through the Southern Sandhamn fairway would be restricted by the prevailing wind force.

The Northern route could possibly also be confirmed by radar surveillance data as recorded by the Finnish Coastal Artillery observation stations. These stations, situated on the Finnish archipelago, were monitoring any object entering into their respective sector and handed over the information to the subsequent station along the path of the object. The system was said to have the capacity to follow the ESTONIA all the way from departing Tallinn to the position of the foundering. However, no data was kept from that night other than some record printouts made by the stations on Russarö, Örö and Utö, see also [10] and [13].



During the night of the accident the radar operator at Utö took over and followed an object denoted as unidentified but which was believed to be the ESTONIA. Due to the poor weather conditions the object was lost and did not emerge again before 01:40 where after it disappeared completely at 01:48. After the accident the radar operator mentioned that the ESTONIA seemed to have been in trouble already more than one hour prior to the Distress Call, since she deviated more and more to the south and at reduced speed.

According to the German Group of Experts, [10], the longer distance to be covered when navigating through fairway North of the Traffic Separation Scheme, would imply a too high required speed over ground. This, however, is based on a departure time from Tallinn between 19:15 and 19:30, which has not been confirmed.

In addition here to the ESTONIA was plotted by Watch Officer onboard the AMBER on her way to Helsinki. The CPA (Closest Point of Approach) given by the ARPA radar was only 1.5 nm just aft of SB abeam and as the AMBER was the ship to give way, consequently the ESTONIA was carefully followed by the Watch Officer not only on the radar but also through binoculars. The Watch Officer testifies:

*“The ferry was brightly illuminated and appeared to proceed against wind and sea on full speed, which I could hardly believe. According to the ARPA radar her speed was about 18-19 kts. She was heavily pitching and I saw how she was taking a lot of water on the F’cle Deck which smashed against the superstructure and was thrown up to the bridge windows and spray was all over the vessel.*

*When her bow was smashing into the waves I had the impression that she was almost stopped and was subsequently building speed up again when the foreship was rising.....*

*Our course was 051° and the course of the “ESTONIA” was approximately 260°-265°. Based on our speed of about 13.5 kts and a CPA of 1.5 nm, which is certain, it must have been at about 22:15 / 22:20 hours (CET = 23:15 – 23:20 Ship Time) when “ESTONIA” passed at our starboard side at a distance of 1.5 nm. I have clearly identified the “ESTONIA” and I was really forced to look at her.”*

The above observations made by the AMBER are considered to be rather reliable and would hence indicate that the ESTONIA was in fact heading towards the “Waypoint” at 59°20N, 22°00E as stated by the Trainee 2:nd Mate, C11.



Regardless of what route the ESTONIA had chosen the night of the accident it can be concluded that the Ship was steaming at full speed ahead with all four Main Engines, ME:s, running. Probably the computerized ETA-pilot control system was engaged until the onset of the disaster. Consequently any speed reduction was probably involuntary, caused by environmental forces and, following the passing of the waypoint, by an additional drag due to the engagement of the fin stabilizer(s). This is possibly also confirmed by the statement of the AB Seaman, C16, that the primary concern of the Master while at the Nav. Bridge was; a slip in schedule of more than one hour even though all four Main Engines were running.

The majority of the survivors testify about heavy pitching in head seas and a crew member also confirms spray up to Dk 7 where the crew accommodation was situated. Moreover, prior to the onset of the accident the AB Seaman, C16, noted water pouring down onto Dk 2 through the RoRo-Deck ventilation louvers, the ducts of which terminated on the F' Cle Deck, and one passenger, P1, observed soaking wet carpets in the stair case between Dk 5 and Dk 6.



## **4.2 Bow Visor and Ramp Failure**

### **4.2.1 Bow Visor and Ramp Failure in General**

Already from a hydrostatic point of view it can be concluded that the loss of stability and consequently the list development, as reported by the survivors, can not be generated without the detrimental effect of the free surface caused by water ingress on the Main Deck, Dk 2. It is also a fact that the bow visor was lost sometime during the night of the disaster.

Based on the video material from the ROV and diving operations in October and December 1994, the following observations have been made. Reference is also made to the comprehensive study on the Bow Arrangement Collapse, [12].

- a. The visor hinges are first to break. The damages on the Ship's front BHD:s correspond well to marks and indents on the visor.
- b. The design of the bow visor and ramp arrangement implies that the ramp in its closed position extends beyond the F'Cle Deck and is covered inside a housing constructed between the visor hinges. Hence, it is highly unlikely that the visor could separate and fall off the Ship without inflicting severe impact on the ramp.
- c. The labour of the visor lug plates cutting through the F'Cle Deck and the Deck Transverse at #159 must have required a certain time span, during which the ramp housing at some point reaches the top of the ramp in its closed position.
- d. Prior to a complete loss of the visor, the ramp locking appliances break under the force of the visor and the ramp falls into and rests on the upper "cross bracing" in the visor structure. Indents and marks on the visor structure confirm contact with the ramp.
- e. Damages on the bottom structure of the ramp matches the contours of the Fore Peak Deck. The damages on the tip of the ramp can possibly indicate contact with the bulbous bow.



#### 4.2.2 Failure of Ramp Locking Appliances in Detail

During normal operation the ramp was closed by means of two hydraulic actuators which pulled the ramp to the rubber packings, leaving only a small gap. Subsequently two hooks, one on each side of the ramp were hydraulically engaged to connect with corresponding mating lugs and the ramp was pulled into closed position, where after the locking bolts, two on each side of the ramp, were engaged into the corresponding mating boxes.

When looking in detail on the video sequences monitoring the ramp locking appliances the following observations were made, reference is also made to the comprehensive study on the Bow Arrangement Collapse, [12]:

- a. The cylinder operating the PS ramp hook is fully extended and the hook in its locked position. However, a closer look reveals that the hook appears to be cut off.
- b. The SB ramp hook could not be found on any of the reviewed video sequences.
- c. The PS Upper locking bolt is fully extended, while the corresponding mating box support structure is fractured.
- d. The PS Lower locking bolt is only partially extended, while the corresponding mating box support structure is fractured.
- e. The SB Upper locking bolt is fully extended, while the corresponding mating box top plate seems to have been cut off by burning.
- f. The SB Lower locking bolt is fully extended, while the corresponding mating box top plate is crushed in around the bolt.

From the above it is conceivable that some misalignment of the ramp or the ramp hinges made the engagement of the ramp hooks impossible, therefore these devices were eventually cut off. Subsequently, having lost the capacity to fully pull the ramp back towards the packings, a proper operation of the locking bolts was then impeded, especially the unlocking when extensive friction would hinder the bolts to retract.

The above assumption can be supported by the statements of a survivor, a truck driver who had frequently been travelling with the ESTONIA. He reported about considerable problems locking and un-locking both the bow visor and the bow ramp at departure and arrival. Many times crew members had to work on the locks using sledge hammers. This testimony is also confirmed by several other witnesses interviewed by the German Group of Experts, [10] and actually to some extent documented as photos by one frequent ESTONIA traveller, P93.

It is furthermore plausible that upon the departure from Tallinn the ramp was closed and locked by at least the PS Upper and the SB Lower locking bolts and that the PS Lower locking bolt was extended partly into the mating box, as far as the bolt's bevel would allow, whereas due to problems to disengage the locking bolts, the top plate of the SB Upper mating box had been cut off prior to the accident.



During the development of the disaster, eventually the bow ramp is closed either by wave impact or by gravity when the list is close to or exceeding 90°, leaving just a small gap. Structural damages on the bottom of the ramp are noted by two survivors, P3 and P34, when they are climbing down the closed ramp at a list exceeding 90°. Moreover, in an early testimony, the AB Seaman, C16, states that his life raft drifted just below the emerging fore body. He then noted that the visor was missing but the ramp was still in place leaving a small gap.

#### 4.2.3 The Preventer Wires

Preventer wires, which are normally used only when there is nothing to support a lowered ramp such as in the case of dry-docking, were found on the wreck to be attached to the front bulkheads. However, the SB lower end was found to be detached from the ramp eye-plate and with the shackle with its bolt still in the wire eye. The PS lower end could not be seen in any of the reviewed video sequences, but the corresponding ramp eye-plate was found to be empty.

These observations can not be explained. However, if the failure and loss of the visor and subsequently the forced opening of the ramp during the night of the accident is accepted, then the lower ends can not have been attached at departure, otherwise the weakest link in the chain, eye-plate or shackle, would have been found broken. The AB Seaman, C16, testifies in one of the latest interviews that some painting work was carried out on Main Deck, in harbour prior to the departure on the 27:th of September. He also states that the ramp was then operated and partly opened, [11].

#### 4.2.4 The Ramp Guard Railings

On each side of the ramp, guard railings were welded to the ramp side bars. When reviewing the video recordings from the subsea operations on the wreck, these railings were found to be missing. Some pieces of the SB railing, which appeared to have been cut off, including the hinged gate, were later discovered on a ROV video sequence, laying some 250 m abaft of the Ship's stern.

It respect hereto, it should be noted that when engaged the ramp locking bolts are on both sides protruding ramp guard railings. Hence, again if it is accepted that the ramp has been fully open during the accident, then the railings must have been ripped or sheared off by the engaged bolts.



## 4.3 The Onset and Foundering Development

### 4.3.1 Early Perceptions

Banging noises from the bow area noted already at close to midnight and even more frequently found in the testimonies at around 00:30 hrs may impose that the failure of the visor was initiated rather early. Two passengers, P19 and P79, testify about a surge motion that gave the impression as if the Ship had grounded; the Ship stopped abruptly and people on the dance floor fell.

One passenger P42 testifies that he was standing in the FWD stair case on the PS at Deck 7 from where he was looking out through the front window. He could see the bow and noted that a floodlight was directed on the F'cle. At 00:26 he observed green water on F'cle Deck and that a large part of the bow was bouncing up and sinking. A transverse gap was noticed, through which much water was gushing up. The cascades of water seemed to be heavier on the starboard side.

Some of the early observations close to midnight can of course be a consequence of a misinterpretation of what time (CET or EET) the witness was referring to. They can also be true perceptions of a change in motion due to the activation of the fin stabilizers. The lit floodlight prior to the list however, which was noted also by some survivors, may indicate some degree of early awareness about the situation among the Officers on the Nav. Bridge. It is rather unlikely that the disturbance caused a spotlight on the bow of the Ship would be accepted in the middle of the night in the prevailing weather conditions.

The AB Seaman, C16, has testified that; close to 00:45 hrs on his round while standing just in the vicinity of the bow ramp he suddenly experiences a deep pitch followed by a heavy impact that almost made him fall backwards and a noise standing out from the other wave impacts. He reports to the Nav. Bridge and is ordered to investigate the situation. After some minutes he receives the permission to continue his round, as no failures could be detected. The AB Seaman, C16, is noticed on the surveillance camera monitor by the 3<sup>rd</sup> Engineer, C36, on watch in the Engine Control Room, ECR. The 3<sup>rd</sup> Engineer relates this to about 01:00 hrs or maybe five minutes later.

During the hospital visit after the rescue two crew members, C6 and C15, overheard a conversation at which the Security Officer, C28, of the ESTONIA told about a conversation over walkie-talkie in which the AB Seaman, C16, reported about quite a lot of water on the Car Deck, prior to the significant permanent list. This statement is also overheard by the 3<sup>rd</sup> Engineer, C36, in the ECR.



Furthermore, when waking up in his cabin due to the developing list, the 2<sup>nd</sup> Engineer, C38, gets dressed and looks out into the companionway in the Crew Accommodation on Deck 7 when he sees the 1<sup>st</sup> Engineer and the Refrigeration Engineer, C42. The 1<sup>st</sup> Engineer then states that the Visor was broken and that the ship should better be grounded. The statement was made prior to the “Mr. Skylight” alarm. A corresponding testimony is also given by the Refrigeration Engineer.

#### 4.3.2 The Statements of the three Key Witnesses in the ECR

In his earliest testimony the 3<sup>rd</sup> Engineer, C36, on watch in the Engine Control Room, ECR, during the accident, reports that about 01:00 hrs he felt two heavy impacts against the bow. At 01:15 hrs he could see, on the ECR monitor, water entering the Car Deck, Dk 2, via the ramp. Concurrently he heard the AB Seaman, C16, reporting to the Nav. Bridge about water on the Car Deck.

In his second testimony the 3<sup>rd</sup> Engineer states that; following the impacts he could see, on the ECR monitor, heavy water ingress at the sides of the ramp. He also testifies that prior to the impact he had also seen the AB Seaman on the monitor.

After the permanent list the 3<sup>rd</sup> Engineer did only look into the monitor once as stated above. Thereafter he was standing at the ballast operations panel, a position from which he was not able to see the monitor. As the inclination increases the possibility to move freely was impeded.

The Motorman, C7, states that; at 00:46 hrs he observes, on the ECR monitor, some water pouring in at the SB side of the ramp. (In later testimonies the Motorman withdraws this statement.) Following the first list, the Motorman was told by the 3<sup>rd</sup> Engineer that the situation was bad since the ramp had broken. The Motorman then looked into the monitor and saw a significant amount of water and even waves on the Main Deck. He stayed at the monitor and switched between various cameras directed towards different locations on the Main Deck until after the Main Engines had tripped and stopped.

The Systems Engineer, C33, who was in the Sewage Treatment Room at the onset, testified that he, about to 00:50, experienced two-three heavy impacts where after the Ship took a slight list that caused some barrels started to slide on the deck. After the following impact the barrels which had stopped now continued all the way to the side shell. At that point the Systems Engineer realised that something was amiss and rushed to the ECR, a walk that would normally take about 1-2 minutes but due to the severe ship motions and the increasing list this path may according to the Systems Engineer have required a somewhat longer duration. When entering the ECR the Systems Engineer was told that water had flooded into the garage on the Main Deck. When he looked in the monitor he saw large quantities of water entering at the ramp. The Systems Engineer then strives to reach the ECR phone in order to contact the Chief Engineer but falls at the table which is sheered off at its welds, apparently due to a significant increase of the inclination. After this incident the Systems Engineer does not look again on the ECR monitor.



The Systems Engineer remembers seeing non-prioritized consumers being switched off from the electrical switchboard just prior to his escape together with the Motorman. The two crewmembers state that, during their escape the power was momentarily lost when they had reached Dk 6 level, which may imply that the Aux. Engines failed and the Emergency Generator was engaged within some five minutes after the System Engineer and the Motorman left the ECR and hence about seven minutes after the Main Engines stop.

Moreover, when the ship is listing severely close to laying on her side one passenger, P76, observes two crew members climbing out of some trunk in the vicinity of the funnel, one of which is shouting in English: "Water coming up from Car Deck", hence confirming the

The 3<sup>rd</sup> Engineer starts his escape after the Aux. Engines have tripped. He just manages to climb the stairs up to Deck 8 when the Emergency Generator fails and the lights went out for good.

The statements of the three crewmembers in the ECR as summarized above do not impose any contradiction. The ECR clock however, must have been close to 15 minutes ahead of "true" time.

It must be considered as quite plausible that the three witnesses in ECR may have observed water ingress at ramp sides prior to a full separation of the visor and hence when the ramp is resting onto the visor structure. Scoring marks on the visor upper cross bracing confirm contact with the ramp grillage structure. Furthermore, if the Systems Engineer, C33, is correct the ramp had not been fully open prior to his escape, since the sketch made by him indicates a tarpaulin at the top of the ramp which is still there when the crew is watching the monitor.

The Motorman, C7, understandably very close to a state of panic appears to be the last witness to see the ramp in a "closed" position. However, out of the three crewmembers the Motorman seems to be in worst mental condition. As time elapses after his rescue he seems to become more and more uncertain of what he observed during the accident and in his later testimonies he withdraws some significant observations related to the flooding of Main Deck.

The heel-over and resulting increased inclination that forced the Systems Engineer to fall and the ECR table to sheer-off at its welds, could have been the result of massive water ingress when the visor was lost and the ramp pulled down to a fully open position.

#### 4.3.3 Noise Scenarios

Quite a few of the interrogations were held in accordance with a protocol that included the question about specific noise such as an explosion. Within the reviewed material none of the survivors have been found testifying any noise related to an explosion but rather to more a heavy hammering or banging metallic noise, standing out from the sea impacts just prior to the extensive heel-over.

At least two witnesses also testify about noise from Main Deck (Dk. No.2) earlier the night of the accident. One of them relates the noise to a loose item sliding across the deck and smashing into the ship's sides.



#### 4.3.4 Deteriorated Stability

Close to 01:00 hrs some witnesses experience an increase in the roll motion. The Ship heels over and back, eventually she does not come back to an upright position, but rests for a moment at a list of about 10°. After some additional minutes the list increases significantly causing loose items to fall over or to slide across the deck, even a rather heavy casino table starts to slide.

The AB Seaman, C16, after having been given the order to further investigate the situation on Main Deck stops at the reception at Dk 4, in order to ask the Receptionist to unlock the Car Deck doors upon which the ship suddenly takes deep heel-over to the SB side making them to fall over. After having recovered somewhat the Receptionist announces, with a trembling voice, the “Häire, Häire” alarm over the public system.

The 3<sup>rd</sup> Engineer testifies that following the two heavy wave impacts the SB list was immediately increased by 2-3°. Within a couple of minutes the inclination was 10-15° while the ship continued her voyage with all four Main Engines running. He was then requested by the 4<sup>th</sup> Mate to compensate the heel by means of ballast. An operation which was impossible since the PS heeling tank was already full and due to the inclination the ballast pump was sucking air.

#### 4.3.5 Water Ingress

At least six survivors experienced some water on Deck No. 1 or water ingress at the sliding doors at Deck No. 2. None of them reported any massive flooding. Probably one of the last survivors from the accommodation area at Deck No. 1 hears the “Häire, Häire” from this deck level and still manages to ascend without the experience of massive flooding.

While still in the ECR prior to ascending up to Deck No. 8, the System Engineer, C33, had the impression that the Officers on the Navigation Bridge were informed about water ingress somewhere into the hull and that the Bilge Pumps therefore were running. Since there was no bilge suction at Car Deck level and above, the water ingress indication should presumably have been originated from within the buoyant hull.

It can be noted that the 3<sup>rd</sup> Engineer, C36, testifies that when he left the ECR the engine room was dry.

One survivor who was resting with his head on the SB side lining in the Cafeteria, on Deck 5, when the list was initiated. He testified that the when he started to evacuate the outside water surface was already just below the window. When making his way up to the SB side he observes a wedge of water at the location where he was earlier resting. After some time he could also see water against the Cafeteria aft doors.



#### 4.3.6 WT-Integrity

The alarm “Mr. Skylight to Number One and Two” is, according to the ESTONIA’s Safety Manual [7] a cryptic order to the Safety Organisation to man the fire stations one and two. Some crew members did start to execute the order but the fire station located on the Car Deck (Dk. No. 2) could of course not be manned.

However, in case of Collision, Grounding or Leakage the announcement, according to the ESTONIA’s Safety Manual, [7], should be “Mr. Skylight One and Two, Damage Control”. This announcement should according to [7] be preceded by the closing of all WT-doors. Thereafter should the WT buoyant hull be searched from stem to stern.

While escaping from Deck No. 1, some survivors testify about ringing noise which in some cases were interpreted as some kind of fire alarm. However, it seems quite conceivable that this ringing noise was actually the local alarm which is sounded when a WT-sliding door is closing.

Moreover, the Systems Engineer, C33, has testified that just when he entered the ECR, or a couple of minutes later the sliding doors were released and closed behind him. He also has made the observation that when he and the Motorman, C7, had left the ECR in order to escape through the stairs in the engine casing, they had to pass a WT-door (*at #71*) that was closed. This is also confirmed by the testimony of the Motorman. In addition hereto, also the 3<sup>rd</sup> Engineer, C36, testifies that the WT-doors were closed when he left the ECR.

It could be noted that the majority of the transversely mounted WT-doors were hinged so that the closing was of these doors was from the PS to the SB. Hence, when the sliding doors were remotely released after the SB list had already developed, the hydraulic pressure did not have to overcome any gravity forces.

#### 4.3.7 PS Turn and Reduction of Ship’s Speed

In his attempt to overcome a commencing seasickness one witness, P28, went out on the balcony aft on Deck 6 to get some fresh air. After having rested on the balcony’s starboard side for about 35-45 minute the Ship suddenly heeled over to starboard, tables inside the adjacent restaurant came tumbling down towards the bulkhead and the witness realised that something was wrong. In his attempt to reach for the higher port side, due to the list he is forced utilise the aft railing. While making his way aft, looking over the aft bulwark, he notices a reduction of speed and that the Ship was turning to port.

Another passenger, P30, notices, when reaching the open Deck 7 that the lights from the two “Finland Ferries” (SILJA EUROPA and MARIELLA) appeared to be on the “wrong” side. He could now see these lights from m/v ESTONIA’s port side over the stern quarter. Hence, the bow of the ESTONIA must at this point have been directed close to South.



In addition, a Motorman, C45, who woke up due to the list, heard the engines running but according to his experience the propeller pitch was set to zero. It appeared as if the ship was making headway due to momentum but without propulsion. He also realised that the ship was turning to port.

A further confirmation of the PS turn is given by the fact that at least three witnesses testify that the vessel, having a SB list, is inclined down towards the wind, i.e. at some stage the ship's SB is side facing West or South-West. Some survivors, P56, P76 and P92, testify that when the funnel starts to immerse a heavy smoke or rather steam is covering some groups gathered on the vessel side shell.

Another witness together with a group of passengers had the intention to launch a life raft by sliding it down the PS side towards what seemed to be the leeward side. However, as the inclination exceeded 90° the raft was actually launched against the wind and waves. Here at the windward side a lot of other rafts, lifebelts and debris were gathered and thrown against the ship.

At a rather late stage when the ESTONIA is listing about 135 deg, in order to draw the attention from two other ships, presumably north of the ESTONIA, one witness shoots four photos from the ship's bottom aiming for these two ships. He is sitting on the bilge keel looking aft meaning that the after body is directed close to the North.

In addition the 2<sup>nd</sup> Mate, E1, on the MARIELLA testifies that; in the corner of his eye he sees on the radar the track of a rather sudden port turn of the ESTONIA.

At an unspecified point of time the 3<sup>rd</sup> Engineer, C36, in the ECR observes that the engine speed has been reduced, from the Nav. Bridge controls, to just above idling speed.



#### 4.3.8 The Sinking Development

A majority of the survivors testify that they were washed overboard by a wave when the list was close to or even more than 90°. The wrist watch of one passenger, P49, is smashed and stops at 01:31 when he is being washed off the ship's side at a list close to 90°.

The sliding off the side and eventually bottom shell plating are not reported as dramatic falls from a high "freeboard". In some cases the reported anxiety is more related to the fear to be caught by the railings and lines at the higher decks, i.e. the sliding movement is in many cases "upwards" when the list is more than 90°.

Based on the above it seems plausible that a significant part of the reserve buoyancy is lost already when the Ship is laying on the side at 90°.

Many witnesses also noted an increasing trim by the stern and in some cases also a "beach line" developing, below which the after body of the Ship was already immersed. As the list increases not only the SB Bridge Wing is immersed but eventually also the PS Wing. However, at a very late stage, due to the trim, the Nav. Bridge is again visible and water is pouring out from the windows just prior to the total loss.

It should furthermore be noted that when the lowest part of the sinking and trimming the ESTONIA touched-down on the seabed at a water depth of about 80m, the sinking development was most likely slowed down.

#### 4.4 The Distress Traffic

Already at 01:08 hrs a first distress call is heard on VHF channel 16 by an AB Seaman onboard a vessel in the vicinity. The call comprised only three Mayday, Mayday, Mayday, hence no identification of the Ship in distress could be made. When informing the officer in command on the bridge the AB Seaman was told that if he had really heard a distress call the vessel in distress would certainly repeat the call.

The official distress traffic starts at close to 01:22 with the rather desperate call: Mayday Mayday ESTONIA please; an urge that may imply that the officers onboard the ESTONIA had tried for some time to receive a response on their distress call. The call is made by the 2nd Officer but within two minutes the 3<sup>rd</sup> Officer takes over the communication. After having established contact with the SILJA EUROPA the 3rd Officer continues in Finnish, stating, just prior to 01:25, that the ESTONIA suffers a bad list to SB amounting up to 20-30° and need assistance. At this stage the reported list appears to be somewhat understated. Possibly the reported list was derived from a libell type inclinometer normally having a range of about  $\pm 30^\circ$ .

When asked about the position, the 3<sup>rd</sup> Officer states just after 01:25 that the ESTONIA suffers a black-out consequently they can not state any position. This statement may reveal that the Aux. Engines were lost by 01:25, but appears otherwise quite strange since all main navigational aids had power supply from the emergency generator. In addition hereto the safety radio system was supplied by an Un-interruptible Power Supply, UPS, battery pack, meaning that the communication could continue also after loss of the Emergency Generator.



A possible reason for the inability to announce a position could be the fact that the GPS navigators were both installed at the conning position close to the centre line of the ship, a position that, under the severe list, could only be reached after a great effort.

During all transmissions from the ESTONIA several alarms are audible in the background, which again could imply that at least the Emergency Generator supplied power to this equipment. However, also these items could possibly have been supplied by the UPS battery pack.

At 01:29:39 the last message is transmitted from the ESTONIA, where after the 2<sup>nd</sup> and 3<sup>rd</sup> Officer climb out from the Nav. Bridge and strive to assist among others the Systems Engineer to release life rafts.

#### **4.5 The Condition of the Ship**

According to [10], some passengers travelling with the ESTONIA prior to the disaster have testified that during voyages in heavy weather there was always some amount of water on the Main Deck (Dk 2).

A Swedish Pilot has given a testimony to the GGE in which he reports of an occasion 26 December 1993 when the weather conditions were rather heavy with wind speeds reaching 22 m/s. The pilot was actually splashed down from above when the pilot door was opened. In his testimony he states that on his way to the lift he had water about 20 cm high up his boots and estimates that at about 5-10 cm of free water was covering the full deck area. The water was splashing about 1m high upon the centre casing.

The day of the departure preceding the accident, 27 September 1994, two Swedish Maritime Administration surveyors performed an educational Port State Control exercise for some Surveyors of the Estonian Maritime Administration. The ESTONIA was selected as subject vessel for the training exercise. Among other items, the survey the SMA Surveyors made the following notations, [9]:

- The Surveyors got the first impression that the ship was well managed and clean. However, the Surveyors could from some reason not be not provided with some important documentation such as the Ship's Stability Booklet, Damage Control Plan and the Cargo Securing Manual.
- On the Navigation Bridge, the so called MIME-Panel on which the indication of WT-closing was presented; displayed green light when the WT-doors were open. According to prevailing rules should the indication be green when the doors were closed. This seemed to cause some confusion also to the 1<sup>st</sup> Mate who was attending the educational survey.
- Some WT-doors were later tested locally and proved a satisfactory function. However, it appeared as if the local controls, at least in the Machinery Spaces, were overridden by the panel on the Nav. Bridge; as soon as the WT-doors were closed locally they were immediately operated to open again. In the Deck No. 1 Passenger Accommodation area the WT-doors proved a satisfactory function.



- Somewhere on the Car Deck and presumably in the Bow Thruster Room some hatches into to the watertight integrity were open. The impression was that the hatch covers had not been closed for quite some time. According to the SMA Surveyors were these covers closed after the SMA notation. At least one cover had to be forced into position to be closed.
- The SMA Surveyors confirmed a torn down rubber seal half a meter up at both sides of the bow visor / ramp. When noted, the Chief told the Surveyors that the seal was to be removed at the next docking.
- As the impression was that the Ship was very clean, no inspection of scuppers was made.
- Some worn out and broken cargo lashing equipment was stowed together with functional lashing equipment. When noted, the Surveyor got the reply that the broken equipment was used "if necessary".



#### 4.5.1 Ship Wreck Details

In the year of 1994 the following subsea activities were recorded.

- 29-30 September 1994 Search for and locating of the wreck, performed by the hydrographic survey vessel SUUNTA equipped with a side-scan sonar and a multibeam echo sounding system, Finnish Maritime Administration (FMA)
- 2 October 1994 ROV surveys and video recordings of the wreck, executed from the Oil Pollution Control Vessel HALLI, under the command of the Finnish Frontier Guard (Archipelago Sea Coast Guard Section)
- 9-10 October 1994 Additional ROV video recordings of the ramp and visor area, executed from the Finnish Coast Guard vessel TURSAS.
- 12-19 October 1994 Search for and locating of the Visor, performed by the Finnish Coast Guard vessel TURSAS equipped with a side-scan sonar and a low-frequency echosounder. The Estonian Coast Guard Vessel EVA-200 equipped with a side-scan sonar took part in the search.
- 18 October 1994 The visor was recovered by the RSwn mine-sweeper FURUSUND and the FMA multipurpose icebreaker NORDICA.
- 2-5 December 1994 Diving surveys supplemented by ROV inspections of certain areas were carried out by the Rockwater AS as commissioned by the SMA. These activities were performed in order to provide information about the interior condition of the vessel and the feasibility of lifting the entire wreck. Rockwater was also commissioned to perform, for the JAIC, a survey of the navigation bridge and vessel's bow area.

Today the site of the wreck is classified as a sanctuary, diving and other submarine activities in the region that could help to shed some additional light in the chain of events causing the disaster are thus not allowed.



The diving activities as ordered by the Commission and carried out in December 1994 by Rockwater AS are summarized in the JAIC Supplement Condition Survey report, [8] and further documented as video recordings. The following primary observations were made:

- The aft transverse structure has suffered massive damages from Deck No. 7 to Deck No. 8, from SB to Port side, during “touch-down” on the seabed. An indent in the deck is somewhat more pronounced on the PS side which confirms a full capsized. All cabins within this region were collapsed and the windows were broken. No casualties were found on the inspected area of Deck No. 8.
- On Deck No. 7, comprising Crew Accommodation, 11 PS cabins were inspected, in four of which a total of 12 casualties were sighted. The relatively high number of crew members that did not manage to escape from PS cabins on Deck No. 7 indicates a rather violent development of the accident. Further down in the Ship the number of victims was increasing and congestions in stairwells were confirmed.
- Most of the cabins surveyed in Deck No. 1 were found to be intact, the exception being cabins 1005 and 1006 closest to centre companionway, the interior bulkheads of which were completely collapsed.
- The only WT-door that was inspected, WT-Door at #110, was found to be closed.
- The rudders were found to be intact and in hard to starboard position, which most probably have been caused by gravity.
- Also the propellers were found in intact condition and at a pitch close to zero. The pitch setting can possibly have been neutral due to loss of hydraulic pressure.

A further observation from the examination of the available video material is that all windows visual on the port side appear to be intact. The ROV is “flying” along the hull side using the blue stripes on the ship’s side as guidance for depth measurements, at which the ROV is operated to touchdown on certain window panes where after the depth is recorded. All windows passed by the ROV also gave searchlight reflections indicating that the panes were still intact.

During the escape several survivors including crew members states that they have observed the PS fin stabilizer in its engaged position. The video recordings from the Rockwater ROV mud line survey together with recordings from the Rabe/Bemis expedition indicate that both SB and PS fin stabilizers appears to be in folded position inside their respective pocket. No signs of damages in way of the stabilizers can be seen.

As was noticed by the German Group of Experts, one ROV-film sequence reveals a gap at the SB stern ramp.



#### **4.6 Interview of Diving Team Members**

As an opportunity to interview the only sources who have actually investigated the wreck could provide an enhanced insight into the conditions of the ship during the disaster, and could furthermore facilitate a disqualification of scenarios which do not correspond to the conditions of the wreck, efforts were made to conduct an interview with the Rockwater diving team members.

Today the company Rockwater AS does no longer exist and the staff of 1994 has been dissolved. However, within this study four persons were approached:

- a. The manager of subsea activities at Rockwater AS,
- b. The Onshore Project Manager
- c. The Onboard Project Manager
- d. The Onboard Survey Operations Co-ordinator and Dive Supervisor

From these contacts the overall conclusions made are that the Rockwater team took very seriously upon their task and carried out this extremely sensitive operation with highest professionalism. No hole or breach into the hull was ever observed by the team.

The contacts eventually resulted in a telephone conference at which both the Onshore Project Manager and the Onboard Survey Operations Co-ordinator and Dive Supervisor were interviewed, the transcript of which is given below.



Telephone Interview 21<sup>st</sup> February 2008, 12:00 to 13:00

The telephone conference was conducted by Dr. Andrzej Jasionowski, SSRC, and the interviewed former Rockwater staff members both participating concurrently were:

- b. Onshore Project Manager
- d. The Onboard Survey Operations Coordinator and Dive Supervisor

Q: Could you please describe what was your role during the survey?

A: d. was coordinating the survey operation offshore, while b. was the Project Manager onshore with overall responsibility for the project.

Q: When did the operation take place?

A: Between 1st – 5th December 1994

Q: Would you be able to specify the purpose of the pledge of secrecy you were requested to sign to prior to the survey of the wreckage?

A: The purpose of the confidentiality agreement was to assure that no spontaneous communication of the diving team with the media was taking place. Such agreements are commonplace and they are taken very seriously. As far as we can say, these agreements had no relevance to the conduct of survey or subsequent reporting.

Q: How did the divers enter the car deck?

A: No divers entered the car deck. The car deck was inspected by an ROV, which entered through partly opened forward ramp.

Q: Was there any other access entry which would allow inspection of the car deck.

A: No, the only access the divers used for inspection of the car deck was through the forward ramp. No other access openings were made.

Q: There seems to have been some indications that the ROV entered the car deck from a hole close to the sea bed with confirmation by 3D coordinate readings on the monitors. So there seems to have been some other openings.

A: There must have been some confusion with the coordinates, perhaps resulting from misreading or inappropriate calibration, or maybe the readings were from the compass, not GPS. Not sure. The ROV had only one access to the car deck spaces, through the forward ramp.



Q: Who directed the survey of the wreck?

A: All operations were instructed by the police on board the diving vessel. Rockwater only provided the skilled personnel and equipment. Some representatives from the (Swedish) National Maritime Authorities informed that there would be police on board during the operations. The police were interested in identification of location of victims on decks, some views from inside the car deck, and bridge. A geological survey and core sampling were undertaken for supporting possible salvage operations.

Q: How accurately has the hull been inspected, and how was it performed?

A: Some flying of ROV's and there camera's, around the hull, was instructed by the team member of Smit, with the key view again to provide information for performing future salvage operations. Only some points of the hull were thus surveyed / filmed.

Q: What did you observe on the bridge?

A: A number of bodies were found on the bridge. It was impossible to see the clear insignia and thus to identify the persons.

Q: Had there been any instructions to specifically inspect the whole of the hull, with the view of finding a hole?

A: No, no specific instructions to precisely survey the hull were given, nor any such survey taken place. Only a number of locations were viewed, e.g. the bow area. All the filmed recordings from these surveys were given over to the contracting agency, The Swedish National Maritime Administration.

Q: The films show some specific inspections of cabins. Was there any instruction to perform such inspections?

A: A hole was cut into the ship, to enter inside at the level of accommodation<sup>1</sup> so to inspect the location of victims however in most instances entrance was gained through the port holes<sup>2</sup>, sometimes expanding the size of these by cutting further steel away to allow safe access/egress. At any entry point where there was a danger of buoyant material escaping, it was subsequently re-sealed. Going through these spaces was very cumbersome, the inside structures were destroyed, with pipes and cables hanging around, the water was also very unclear. So the divers would try to find some coordinates, e.g. cabin numbers and thus identify where they are in the ship. The choice of where to survey within the hull was reached before commencement of each entry. The Police onboard would suggest areas that they would like to try to access and we would advise if we felt we could attempt this safely. It was impossible to know what conditions we would find in each entry point or how far into the hull we would be able to access safely. There was no instruction to find a specific person or a cabin.

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<sup>1</sup> The Rockwater staff here refers to hull entry into the accommodation area below main deck by means of cutting hole through the shell plating.

<sup>2</sup> Port Holes here means Windows leading into the accommodation areas above the car deck.



Q: Can you please again confirm that during the hull survey as instructed, have you at any point noticed any sort of breach, hole or any unusual hull indentation?

A: No, there was no such hole observed whatsoever.

Q: There seem to be some reports of diving prior to your diving, i.e. prior to 1-5th December 1994. Have you noticed any evidence which would suggest earlier attempts to survey the wreckage.

A: No, not any evidence of such operation whatsoever. The survey undertaken by Rockwater was a very serious and challenging logistical and technical operation, it would have to be rather well coordinated and well resourced undertaking.

Q: Have you inspected the bow visor?

A: No, we know nothing about the bow visor.

Q: There is a report of seeing sand in accommodation area, after entering spaces below the car deck. Did you observed a lot of sand.

A: It was a result of the extent of silt in water, the water was very dirty, disturbed, with poor visibility, this is what was referred to. There was no observation of sand as such.



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# PLAUSIBLE LIST DEVELOPMENT

