Investigation Report

B1/2008M

M/S TALI, grounding in Jössingfjord, Norway, on 29.1.2008

Translation of the original Finnish report

This investigation report has been written to improve safety and prevent new accidents. The report does not address the possible responsibility or liability caused by the accident. The investigation report should not be used for purposes other than the improvement of safety.

SUMMARY

M/S TALI left Jössingfjord in Norway bound for Tahkoluoto in Finland in the morning of 29 January 2008 carrying ilmenite. She was manoeuvred under the guidance of a Norwegian pilot. After the vessel had left the fiord, the pilot expressed his wish to disembark the vessel and embark the pilot vessel before the usual pilot boarding place. The master of M/S TALI agreed to this. Due to heavy seas, the pilot was not able to leave M/S TALI in spite of several attempts.

The master had manoeuvred the vessel to starboard towards the shore and thus tried to gain better shelter from the sea for the pilot boat. During the manoeuvre the vessel had proceeded so close to the shore that the pilot had told the master to turn the vessel to port and returned to the bridge. Before this the master had already ordered the vessel to turn to port and started the bow thruster to assist in the turn. Due to the inertia of the vessel and the wind and the waves, M/S TALI drifted during the turn so close to the shore that the stern of the vessel hit a rock at about 9:16 Finnish time. The rudder and propeller of the vessel were damaged, and the propeller shaft came loose from its bearings and protruded almost two metres. A leakage gap appeared in the shaft tube, and water began to flow into the engine room. The vessel's pumps could not pump out the water quickly enough, and the water level in the engine room started to rise. When moving, the propeller shaft had broken parts of the cooling water piping system with the result that the main engine stopped. When the water level rose, the pumps stopped, as did the three auxiliary engines one after the other.

The pilot asked the pilot vessel to call for assistance. With the help of the pilot vessel and the bow thruster, it was possible to get M/S TALI to drift to shallower water and anchor her. After about an hour a SAR-vessel and a coastguard vessel reached M/S TALI. At about 12 o'clock the vessel was taken on tow back towards Jössingfjord Port. Pumping equipment was brought onboard the vessel several times during the voyage. The water level in the engine room rose almost to the level of the sea level, i.e. to approximately ten metres. Divers stopped the leakage when the vessel was in port. The engine room was emptied of water, and the machineries were prepared for a thorough repair and overhaul. The cargo was transferred onboard M/S PASILA, another vessel of the same shipping company. M/S TALI was towed to a dock in Stavanger so that the damages could be repaired.

According to the view of the Accident Investigation Board, the cause of the accident was the prolonged attempts to disembark the pilot while the sea was rough. The master manoeuvring the vessel was paying attention to the pilot's safe disembarking. Considering the prevailing weather conditions he noticed too late the fact that M/S TALI was proceeding towards the shore.

THE ABBREVIATIONS USED

ARPA	Advanced Radar Plotting Aid
CL	Center Line
COG	Course over ground
DGPS	Differential Global Positioning System
ECDIS	Electronic Chart Display and information system
GPS	Global Positioning System
HDG	Heading
BB ja SB	Backboard ja Starboard
SOG	Speed over ground
UTC	Universal Time Coordinated
VTS	Vessel Traffic Service,

SISÄLLYSLUETTELO

Figure 1. M/S TALI. *© Hannu Laakso*

FOREWORD

M/S TALI, owned by ESL Shipping Ltd, grounded off the coast of Norway in connection with an attempt to disembark the pilot on 29 January 2008. The rudder and the propeller of the vessel were damaged, and the propeller shaft moved outwards in such a way that the vessel started making water through the shaft tube. The engine room was filled with water to a height of ten metres, and the vessel lost its manoeuvrability. It was possible to turn the vessel away from the shore and make her float towards an anchorage before the electricity production decreased. Within the hour rescue vessels arrived to the scene. The vessel was towed to port and later to a dock so that the damages could be repaired.

Unless otherwise stated, the times mentioned are those used on the vessel. The vessel's clock was set to Finnish winter time (UTC +2). The Accident Investigation Board received information about the incident on 30 January 2008 and initiated a preliminary investigation. The Accident Investigation Board commenced the investigation, and Marine Accident Investigator Risto **Repo** was appointed as the Chairman of the Commission, and Captain Karl **Loveson** and Licentiate in Technology Olavi **Huuska** were appointed as members. The Investigation Report has been translated into English by Minna **Bäckman**.

The investigators visited the vessel twice. There are investigators' notes available on the discussions and observations during the visits. The vessel, the shipping company and Norwegian authorities have provided documents which have been used in the investigation. The GPS recording made by the vessel's electronic chart was at the investigators' disposal. The investigators took photographs when visiting the vessel. In addition to this, there was information about the vessel available on the Internet.

The objective of accident investigation is to improve safety, and thus liability and damage issues are not dealt with. As to its contents and style, the Investigation Report has not been written in such a manner that it would be intended to be used in legal transactions. The conclusions and safety recommendations presented in the Investigation Report do not constitute any presumption of responsibility or liability for damages.

Statements concerning the Investigation Report. The final draft of the report was sent for possible comments to the Master of the vessel and the shipping company. The company informed the commission that they had updated their SMS –manual with regard to pilotage.

Material which have been drawn up during the investigation and which form the basis of the Investigation Report as well as other important documents are available as appendices.

1 EVENTS AND INVESTIGATIONS

1.1 M/S TALI

1.1.1 General information

Name	M/S TALI
Type	Bulk carrier
Owner	ESL Shipping Oy
Operator	ESL Shipping Oy
Flag state	Finland
Home port	Helsinki
Call sign	OJIH
IMO No.	9173692
Year of construction	1998
Place of construction	Finnyards Ltd, Rauma, Finland
Classification society	Lloyd’s Register
Class	LR +100A1 Bulk carrier
Gross tonnage	10098
Net weight	4579
Dwt	13340 t
Length (Loa)	137.15 m
Breadth, max.	21.60 m
Draught	8.19 m
Engine power	6250 kW/450 rpm
Propeller	Controllable pitch, 4.9 m in diameter
Speed	14 kn (Service speed)

M/S TALI is a vessel intended for transporting bulk cargo. The vessel was built at Rauma shipyard by Finnyards Ltd, and she was completed in 1998. There are three crab bucket cranes on the port side of the vessel. There is a controllable pitch propeller on the vessel, and it has been coupled to the main engines through a reduction gear. There is also a bow thruster on the vessel. Figures 1 and 2.

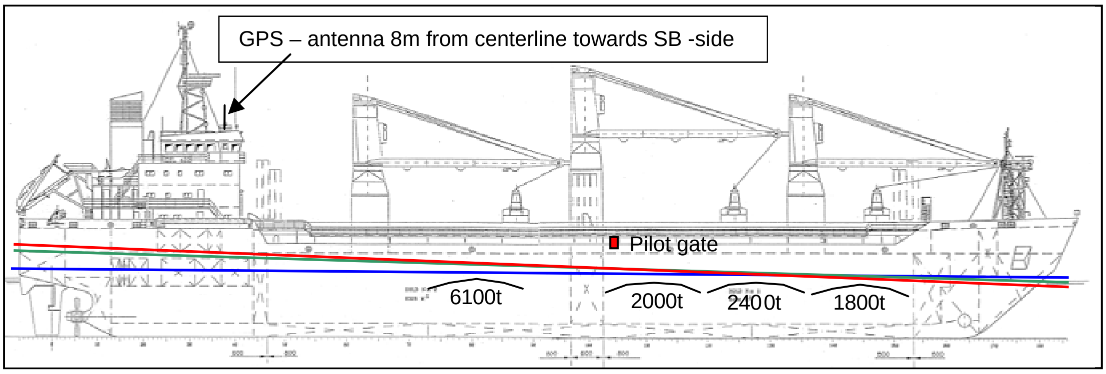


Figure 2. Overall view of M/S TALI. The following have been added to the figure: water lines when the vessel left Jössingfjord (blue), the equilibrium position which resulted from pumping (green) and the position of damage stability calculations[1] when the engine room was full of water (red). The place of the starboard-side pilot gate has also been marked in the picture. It took about 1½ minutes to walk from the pilot gate to the bridge[2]. Moreover; the cargo distribution is shown according to the cargo plan. The loading took place in four stages.

1.1.2 Manning

The crew consisted of the Master, three officers, a chief engineer, two engineers, an electrician, four deckhands, a steward, a catering assistant and one trainee. They were all Finnish citizens and most of them had many years' experience in working on the M/S TALI.

1.1.3 The bridge and its equipment

The vessel's bridge is spacious and equipped with modern navigational equipment[3] (Figure 3).

[1] The vessel's folder on damage stability calculations, the situation which corresponds best with the accident event, pages 11 and 12, appendices 6 and 7 of this report.
[2] Time measured by the investigators.
[3] Litton Sperry Marine type, two radars (X- and S-band) Rascar 3400 M-27 and 3400 M-314 (ARPA). Gyrocompass MK-37 VT, and autopilot ADG-9000. VMS-VT Navigation station (ECDIS). Sailor satellite Comm. H-2095 (Inmarsat C).

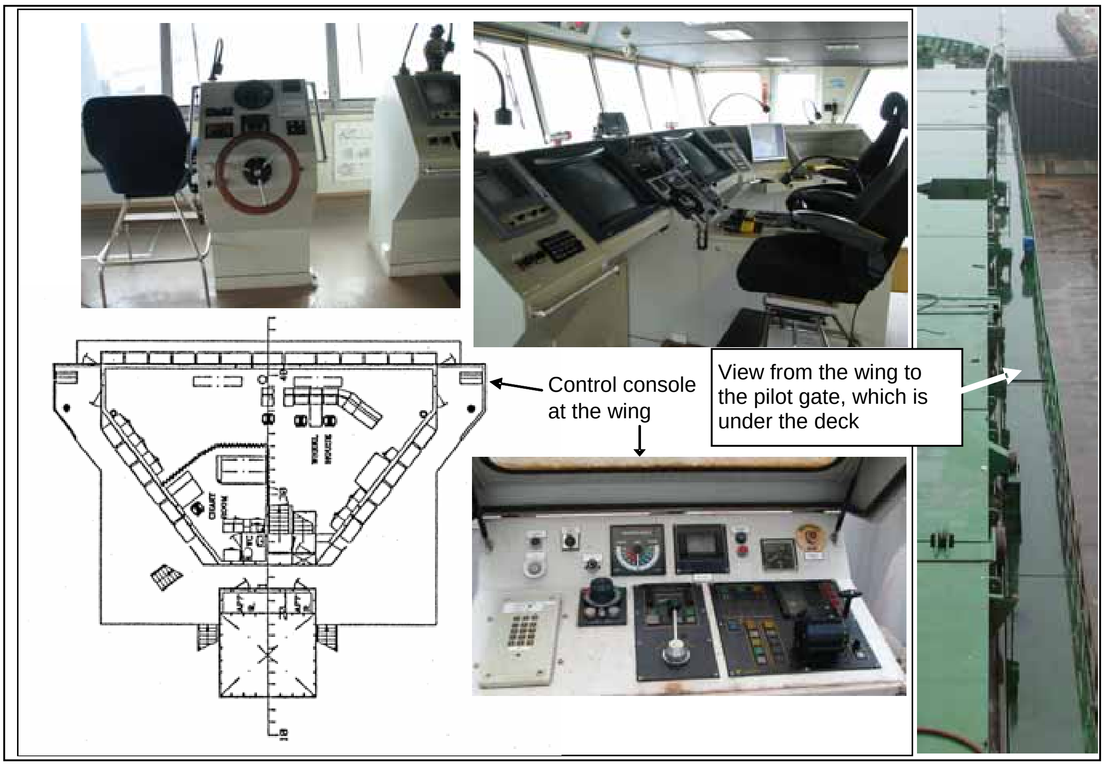


Figure 3. *M/S TALI's bridge. The picture on the right shows the view from the manoeuvring place on the wing to the pilot gate.*

1.1.4 Engines and the engine room

The vessel's propeller is a controllable pitch propeller, 4.9 m in diameter of the type Kamewa CPP 144 XF3/4, left rotation. The propeller is coupled through a flexible coupling and reduction gear to the main engine. The reduction gear is of the type Renk-Tacke HSU 1060 D 450/141 rpm. The main engine is of the type Wärtsilä Vaasa NSD 8L46A. There are three auxiliary engines, which are of the type Wärtsilä 4L20 á 620 kW 400 V/50 Hz 1000 rpm. In addition to this, there is an emergency auxiliary engine.

The bow thruster is of the type Kamewa TT 1650 H/VMS CP 600 kW.

The main engine was operated in combinator mode i.e. when propeller blade angle is adjusted the revolutions of the main engine are automatically adjusted at the same time. This mode has two benefits; the main engine is run at the best torque area and the side force of the propeller is smaller at smaller pitch. The Master told that the control system function was operative and the effect was quickly available. When the bow thruster was operated, all electrical power was in use.

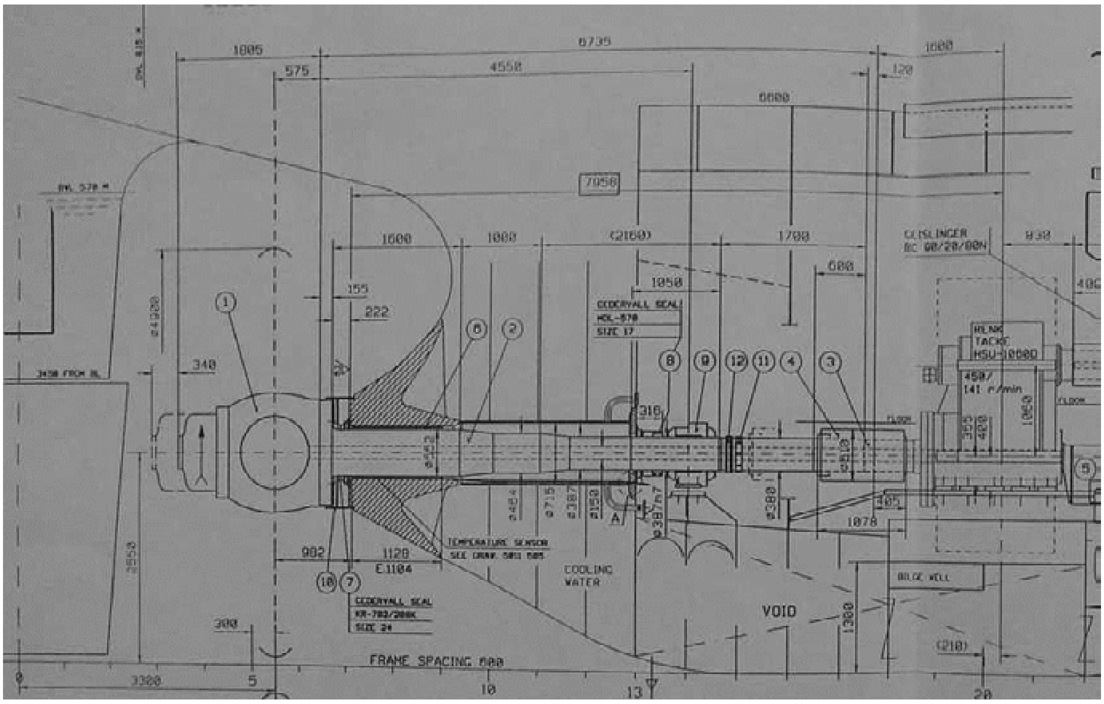


Figure 4. The propeller shaft line. Position 4 is the SKF coupling. The propeller shaft gets thinner about 1,820 mm from the orifice of the opening.

1.1.5 Other systems

There are three cargo-handling cranes on the vessel. The type of the cranes is MacGregor/Hägglunds K25 24-4, à SWL 27.5 t with a hook and 25 t/12.5 m^3 with a crab bucket. The reach of the cranes is 24 metres. The total discharge capacity is 1,000 tons of coal per hour.

1.1.6 Cargo

Cargo holds: Number 1, 40 x 17.60 x 12.2 m; 8,458 m^3,
Number 2, 39.2 x 17.6 x 12.2 m; 8,328 m^3

The vessel was carrying 12,549[4] tons of ilmenite ore. Ilmenite, FeTiO (iron titanium oxide) is a black mineral which has a metallic or partly dim lustre. Ilmenite is the raw material of titanium oxide and other titanium products. Titanium is the ninth most common element of the lithosphere. Titanium oxide, TiO, is the most stabile of the known white powders having pigment characteristics[5]. Titanium oxide is an important colouring agent used in paints and sun-protection creams. The density of ilmenite is 4.7–4.8 t/m. The cargo had been trimmed into the vessel's cargo holds using the crab buckets of the vessel's cranes.

The cargo was intended to be transported to Pori, Finland.

4 Mate's Receipt 29 January 2008, Appendix 2.
5 Pigments are colouring agents. They are very fine, solid substances, which are almost insoluble to the used binding and thinning agents, but which become easily damp.

1.2 Pilot vessel 114

The pilot vessel LOS 114 was receiving the pilot from M/S TALI. The vessel was built at Swede Ship's Djupsvik shipyard in Sweden in 2002. Central information about the vessel: length 17.0 m, breadth 4.9 m, deck height 2.3 m, draught 0.9 m, engine power 2 x approximately 480 kW (2 x Scania DSI 14) and speed over 25 knots, Figure 5.

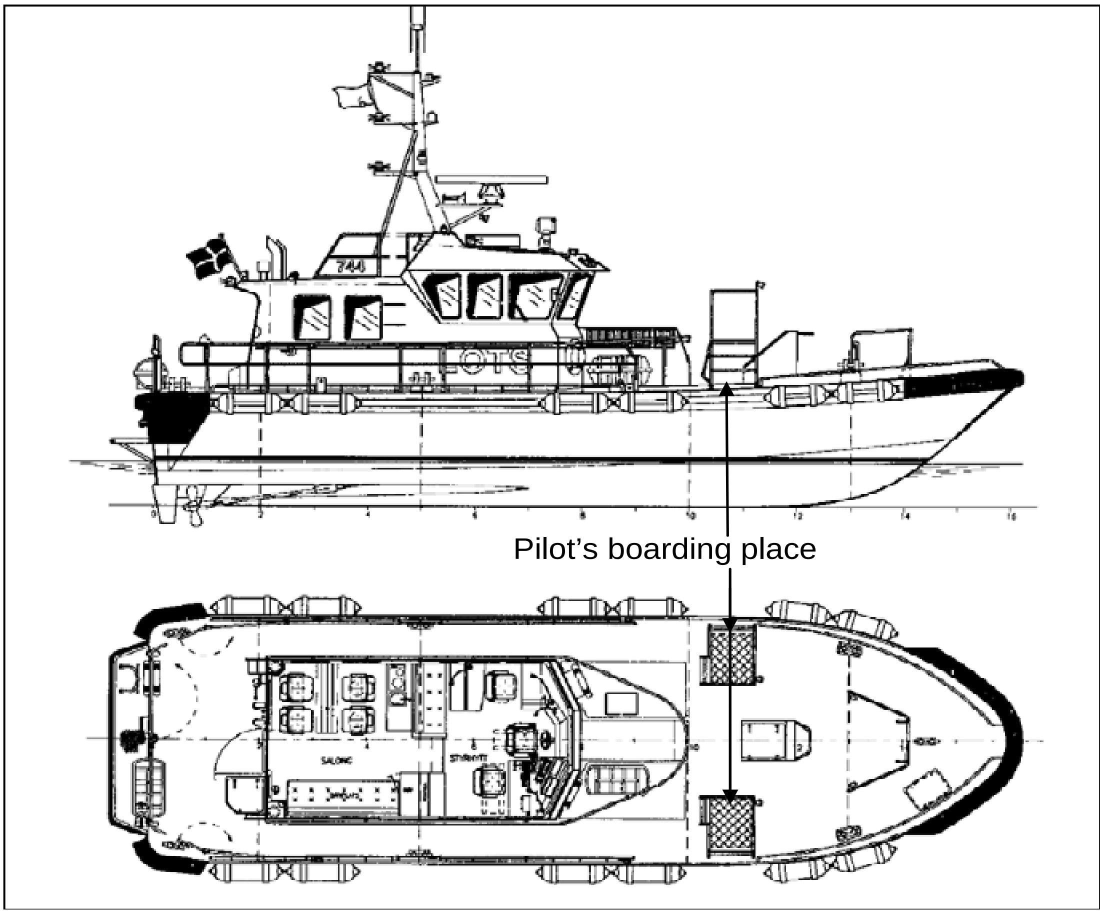


Figure 5. Pilot vessel LOS[6].

1.3 The accident event

The stern of M/S TALI hit a ground on 29 January 2008 at 9:15–9:16 Finnish time. This happened a couple of minutes after the pilot's several attempts to board the pilot vessel had failed and the pilot had started to return to the vessel's bridge.

1.3.1 Weather conditions

According to the vessel's logbook, the wind speed was 8 m/s when the vessel left the port in Jössingfjord fiord; the wind direction was from west, wave height 2.5 m and direction from west. It was dark and the weather was misty. The conditions were similar dur-

[6] The picture of and information about the pilot vessel from Swede Ship's homepage.

ing the pilot's attempts to disembark. The time of sunrise was 9:47 Finnish time. The nautical twilight started at 8:13 and the civil twilight[7] at 9:02 Finnish time[8].

According to the Norwegian Meteorological Institute[9] a southwesterly wind blew until 11 o'clock, after which the wind veered to west and later to northwest. Obrestad lighthouse and Lista lighthouse are the nearest stations reporting wind speed. Wind speeds at these lighthouses have been presented in the following table 1.

A weather forecast with the following information had been issued for the Jössingfjord area ("kysten Åna-Sira – Tananger", see Figure 6) the previous evening at 9 p.m. Finnish time: Forecast until the following evening (midnight Norwegian time), southwesterly wind 10 m/s, rain and mist. Moderate or poor visibility. On Tuesday afternoon the wind veers to northwest, 10 m/s. Showers, otherwise good visibility. Wave height approximately 3 metres, during Tuesday afternoon decreases to 2–2.5 metres. Maximum wave height 5–6 metres, on Tuesday afternoon 4 metres.

Table 1. Weather information at the nearest lighthouses 29 January 2008.

	Finnish time, mean wind/gust, m/s		
	At 8-9	At 9-10	At 10-11
Lista	9/?	12/14	10/12
Obrestad	13/16		

The locations of the scene of the accident and the weather lighthouses have been presented in the following figure.

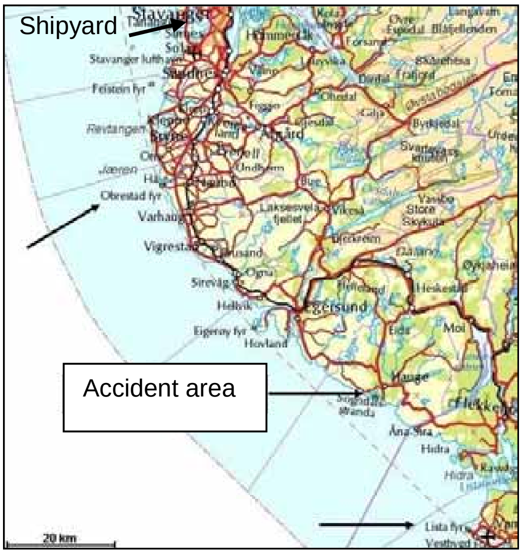


Figure 6. The scene of accident, weather lighthouses and the dock. The figure has been obtained from the Internet pages of Norsk Kartverk.

7 During nautical twilight the sun is 6-12 degrees below the horizon. The name nautical twilight comes from when the horizon is still clearly visible, and there are more and more stars visible in the sky. In olden times sailors could use a sextant to determine their positions. During civil twilight the sun is 0-6 degrees below the horizon. The term derives from the Latin word "civilis" (civil) and "civis" (citizen). In the Middle Ages craftsmen (citizens) could still see enough in the civil twilight to be able to work. The brightest stars become visible.

8 The programmes for calculating sunrise and sunset are available on the Internet, 58 18'N and 6 19'E have been chosen as coordinates.

9 An e-mail received from the Norwegian Meteorological Institute 7 March 2008.

The height changes of the tide were small in the particular area at that time. Water was starting to rise, which could have resulted in a weak current which was parallel with the shore. It is not possible to estimate the direction of the current on the basis of the figure below. According to the information received from Norway[10], there is no height or current information available as to the tide in the area. The change of tide in an area nearby is presented in the following figure.

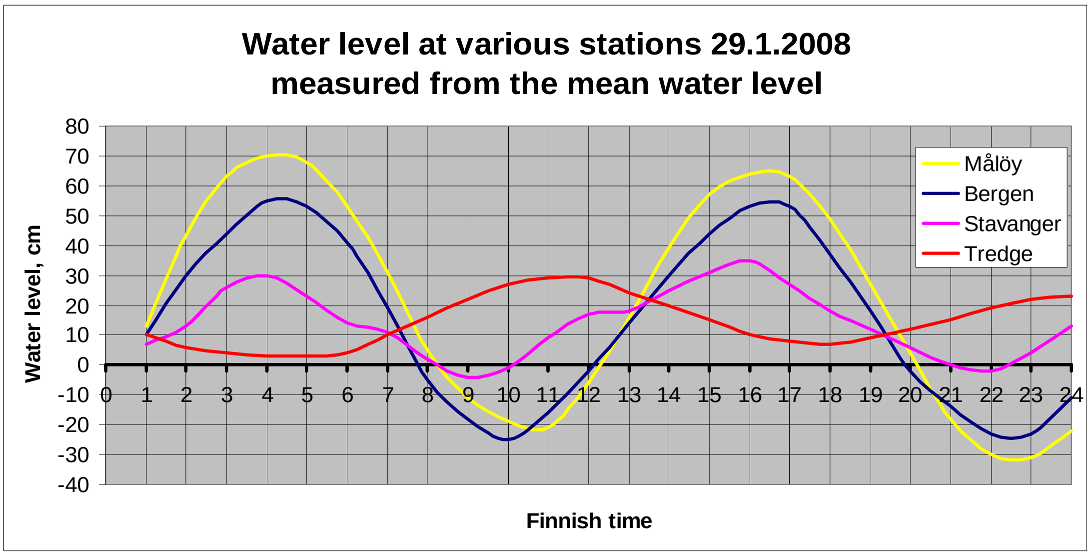


Figure 7. The changes of water level (tide + other changes) on the day the accident took place. The scene of accident is halfway between Stavanger and Tredge. (source: Internet pages maintained by Statens Kartverk, Sjokartsverket, Norge).

1.3.2 The accident voyage and preparations for it

The loading started half an hour after M/S TALI had arrived to the quay at 18.00 on 28 January, and it continued the whole night through. During the night the vessel was dragged[11] a couple of times. The loading operations proceeded as usual, and nothing unusual happened. The loading ended at 07.35, and the vessel left the quay at 08.45 guided by a pilot. Before the departure, the check-lists, which followed the instructions given by the shipping company, were gone through and a route plan was drawn for the route Jössingfjord, Norway–Port of Pori (Tahkoluoto), Finland.

After completion of the loading, the vessel's draught[12] was 7.84 m at the bow and 8.21 m at the stern, cargo 12,549 t, displacement 18,199 t. According to the ship's logbook, the corresponding numbers at departure were 7.82 m and 8.24 m. The vessel's stability in such ore loading condition is very good; the case was close to the ready calculated condition "loading condition ore"[13]. The initial metacentric height was about 4 m, and all stability criteria were filled by a wide margin. On the other hand the rolling of the vessel is severe in this kind of loading condition.

10 An e-mail received from the Norwegian Coastal Administration (Kystverket) 11 April 2008.
11 Dragging means that the vessel is moved longitudinally with the help of mooring ropes and winches.
12 M/S TALI, Mate's Receipt 29 January 2008.
13 The handover material of the vessel, folder 1, theory documents, pos 8, pages 60-63, Appendices 3-5.

1.3.3 The scene of the accident

The coast at the scene of the accident is typical Norwegian coast; the water is deep close to the shore, Figures 8 and 9. The depth of the sea was 30–200 m. The waves rolled from west, where the water was so deep that the waves can be considered to be deep-water waves. Near the shore the waves could be cross-swells because of the reflective effect of the shore.

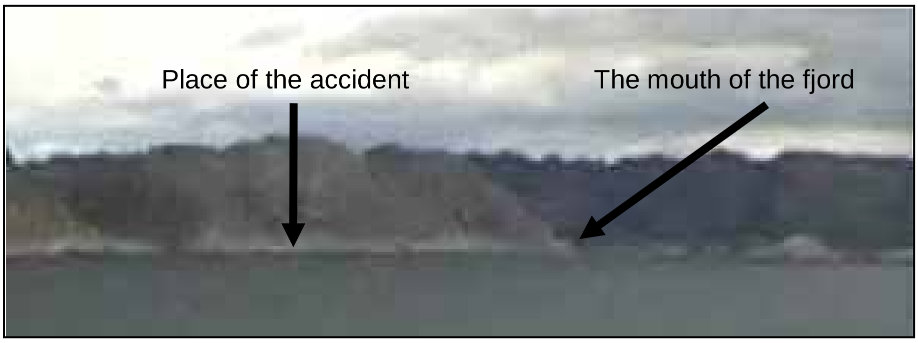


Figure 8. The scene of the accident. (The picture has been taken from a video filmed by a deckhand on the M/S TALI's sistership.)

Several islands form a group at the mouth of the fiord, at the distance of approximately one kilometre, and it could have had an effect on how the waves travelled, Figure 9. The nearest islet/island called Dynga is located approximately 600 metres from the shore. There is a bigger island (Fogsteins) Langholmen further away, at the distance of approximately one kilometre. The islands are low, so it is estimated that they did not have any effect on the wind situation.

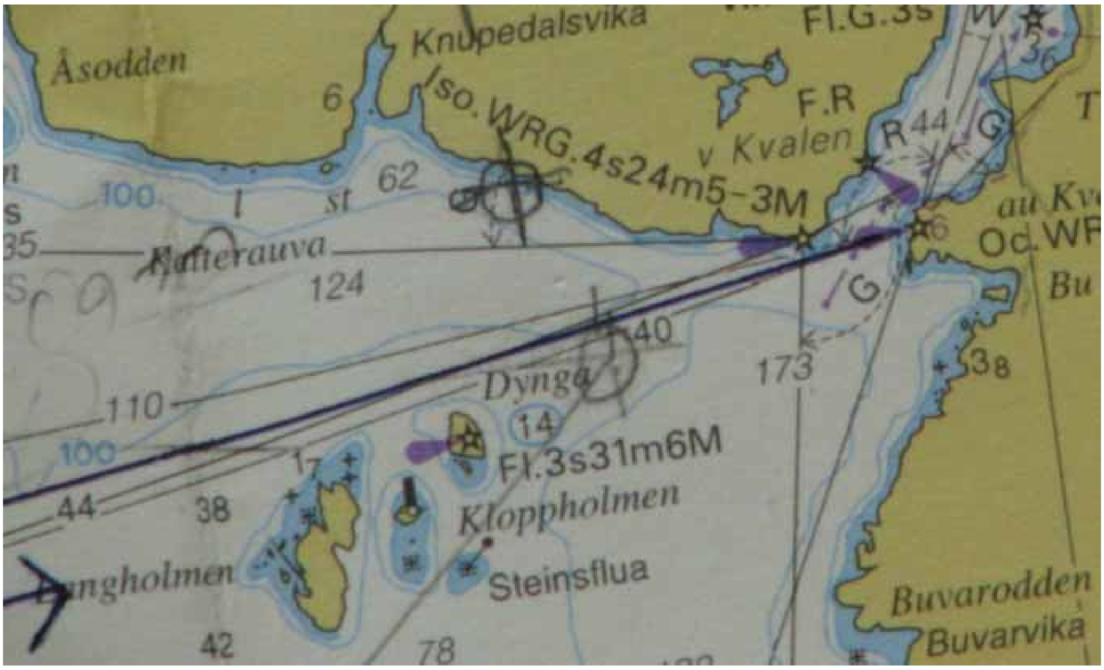


Figure 9. The location of the grounding marked on the vessel's nautical chart.

Figure 10. An Ecdis view of the area. (Not from M/S TALI).

1.3.4 The accident event

After the pilot had boarded the M/S TALI, she left the quay manoeuvred by the Master and guided by the pilot. On the bridge there were, in addition to the previously mentioned, a second officer, who acted as the Officer of the Watch, and an able-bodied seaman, who acted as the helmsman. The Master also acted as a lookout. The following were in use: three-centimetre and ten-centimetre ARPA radars, a gyro compass two DGPS receivers and an electronic chart of the type TRANSAS. When the point of Vestre Kvalen was passed at the distance of approximately 100 metres, the pilot suggested that he could disembark the vessel earlier than at the usual boarding place[14] because of the swell of the sea. The Master approved of the suggestion. The pilot asked the rudder to be turned 20 degrees to starboard and at the same time the engine order "Slow Ahead" was given. According to the pilot, the new course was supposed to be 285–290 degrees. According to what the Master remembers, the new course was defined to 300 degrees.

According to the Master, upon leaving the bridge the pilot requested that if necessary a lee (shelter from the wind and sea) would be made for the pilot vessel.

[14] The normal pilot boarding place is approximately 2.5 nautical miles more to west.

The pilot went down to the deck to the pilot gate with the second officer. The Master and the helmsman stayed on the bridge. The officer was asked to report when the pilot was ready to board the pilot vessel. The pilot and the officer had to wait on the deck for approximately a minute for the pilot vessel to reach the side of M/S TALI.

The Master gave the helm order “five to starboard” in order to provide more shelter for the pilot vessel. He moved to the manoeuvring place on the starboard bridge wing to follow the disembarkation of the pilot and to wave goodbye.

The officer reported on channel 15 that the pilot was ready to board the pilot vessel. The pilot vessel was at the side of M/S TALI, but she moved up and down because of the high sea, and thus the pilot was not able to board the pilot vessel. Several attempts were made, but the pilot vessel was heaving too much (Figure 11). The pilot noticed that M/S TALI had turned more towards the shore. He then ordered the officer to notify the bridge that the vessel had to be turned to port. The Master had then already started a turn hard to port because he had noticed that the distance to the shore was decreasing too much. The Master ran the main engine on “full astern” for some time. The pilot soon noticed that the vessel did not turn and hurried to the bridge. As he was climbing the stairs located at the stern of the vessel, he felt that the vessel's bow thruster was being used. When the pilot came to the bridge at 09:15[15], the stern of the vessel hit the ground.

The main engine stopped, and water began to flow into the engine room. The pilot contacted the pilot vessel and told it to notify Rogaland radio about the incident and ask the coastguard for assistance.

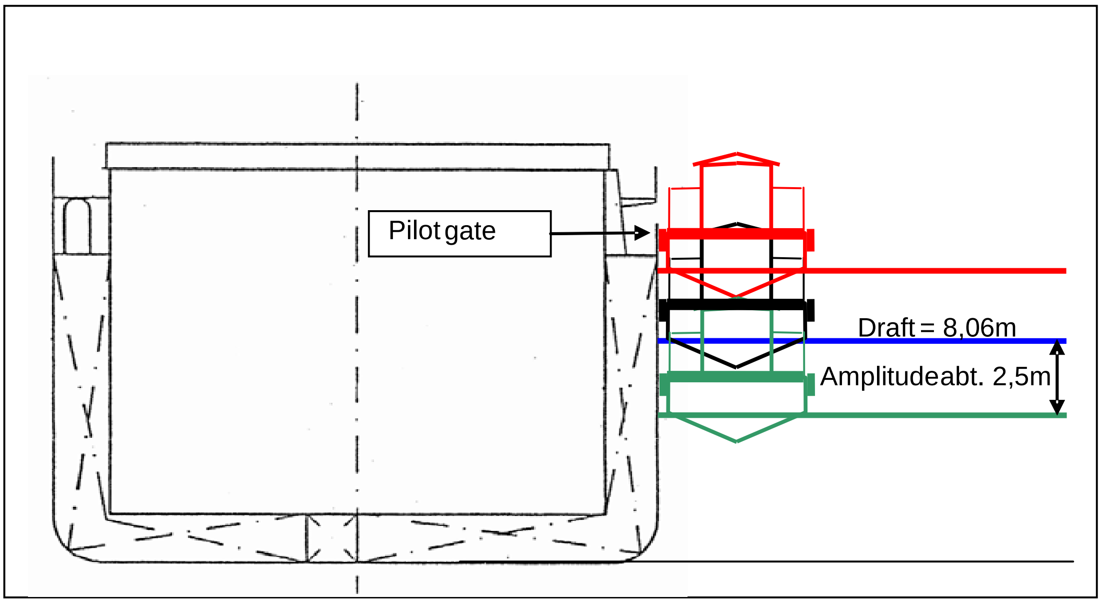


Figure 11. The pilot vessel’s movements at the side of the M/S TALI. The thick line indicates the level onto which the pilot should have jumped.

15 The pilot’s report on 29 January 2008.

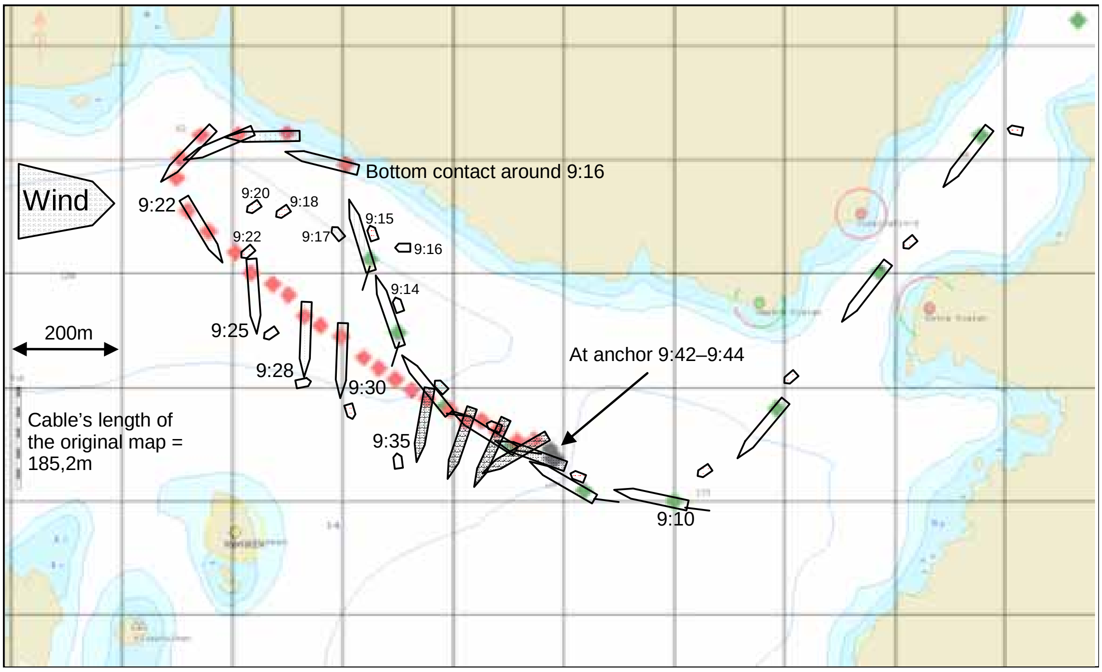


Figure 12. *The movements of M/S TALI and pilot vessel. The dots indicating M/S TALI are according to the GPS with one minute's intervals 9:06–9:44. The GPS antenna was on the vessel's starboard side on the roof of the superstructure, approximately 25 metres from the stern of the vessel (the centre of a green or red dot). Depths less than 10 metres are marked with dark blue colour. The vessel anchored at the position indicated with black dots at 9:42–9:44. The green dots indicate the situation before, red ones after the grounding and black ones at anchor. The position of the rudder has also been sketched for the time interval 09:10–09:15. The vessel marked with a darker colour has lowered the anchor. Even after 9:35, the pilot vessel stayed close to the M/S TALI*

Table 2. The course of events at the time of the accident.

Time	Master	Pilot	Pilot vessel	HDG	SOG	Angular vel.
9:08	On the bridge.	On the bridge. Asks for permission to disembark before the official pilot boarding place.	Approaches from the aft.	219	9.7	
9:09	On the bridge.	Wheel order 285-290[16]/ 300[17], starts to exit the bridge.	Follows at the stern.	220	9.7	Turn to starboard starts.
9:10	Walks back and forth between the starboard wing and CL manoeuvring console.	On his way to the pilot gate.	Close, on the starboard side.	283	7.1	40°/min
9:11	Walks back and forth between the starboard wing and CL manoeuvring console.	Pilot vessel takes up its position. The first attempts to disembark.	Alongside.	300	5	Turn ends, but resumes after a while
9:12	Asks about the situation at the pilot gate.	Attempts to disembark, altogether about 10 times.	Alongside.	302	4.7	Turns very slowly to starboard.
9:13	Had ordered hard to port and the bow thruster hard to port and the engine "full astern" already before the pilot's order.	The last attempts to leave the vessel, starts to go to the bridge.	Alongside.	321	4.7	The slow turn to starboard continues.
9:14	The rudder hard to port. The engine full ahead at 14:20.	Asks the officer to convey the order "hard to port" to the bridge.	Alongside.	341	5.2	The turn has nearly stopped.
9:15	Grounding at 9:15:45.	Arrives to the bridge.	Leaves the side.	342.9	4.7	Starts to turn to port.
9:16	Cursing	Asks the pilot vessel to report the accident.	Draws away.	285	5.9	Turns quickly to port.
9:17	Common planning as to the further measures, e.g. anchorage and follow-up of the situation.		Draws away.	269	3.3	Continues her turn to port.

16 The pilot's account of the events, Norwegian Coastal Administration (Kystverket) Prosedyre 4–05A, 31 January 2008.
17 The ship's logbook, according to which the pilot also asked for shelter if it turned out to be necessary.

1.3.5 Measures after the accident event

According to the alarm print (Appendix 1), an alarm was received in the engine room at 9:14:45. It was reported that the engine room was making water through the Cedervall-seal of the propeller shaft. The water level in the engine room rose. The first alarms about the rising of the bilge water came after 2.5–3 minutes. The leakage was bigger than the capacity of the emergency pumps (a bilge pump 106 m^3/h and a seawater cooling pump 340 m^3/h). The pumps stopped when their electric motors came into contact with water. The cooling water pressures disappeared when the loose propeller shaft broke the piping to the expansion tank. First the cooling of the main engine and then from the auxiliary engines disappeared and the machineries started to get warmer. It was not possible to use the rudder. The bow thruster had been started already before the grounding so that it could help in manoeuvring the vessel away from the shore. It kept going as long as two auxiliary engines were running. The bow thruster made it possible to turn the vessel away from the shore. It has been estimated that the bow thruster was running 20–25 minutes after the grounding. The machineries stopped one after another.

In the deck office the first officer was using the Norcontrol-system to follow the levels in the ballast tanks and alarms coming from the bilge water system. There were not any divergent readings from the ballast tanks. Several bilge alarms came from the engine room. At the same time the boatswain and the second officer, who had gone to the forecastle deck, started preparations for anchoring. The water was too deep to anchor immediately after the turn; depth was 124 m. At 9:25 the towing line was given to the pilot vessel. The bollard of the pilot vessel did not hold the pull, and it came loose at 9:29, but it helped the vessel to turn. With the help of the bow thruster and pushed by wind and the pilot vessel, it was possible to move M/S TALI to shallower water (depth 40 m), and a portside anchor was lowered from the vessel at 9:34. The movement of the vessel ended approximately at 9:44.

Ballast tanks, cofferdam tanks and starboard tank 19 were sounded manually. No leakages were observed in the tanks. At 9:42 there was a blackout and the emergency auxiliary engine started. At 9:44 the lower floor in the engine room was under water. The chief officer carried out the stability calculations. The engine room continued to make water, but according to the observations made on the vessel, the water flow stopped or was minor at 10:40–12:00. A request for rescue pumps to be brought to the vessel was communicated forward by the pilot[18]. The pilot also asked another pilot to assist; the other pilot arrived at 11:00.

The pilot ordered the police to perform a breathalyser test on him and the Master. The result was zero promilles.

1.3.6 Injuries to persons

There were no injuries to persons.

[18] The ship's logbook, extra notes and engine logbook 29 January 2008.

1.3.7 Damages to the vessel

The vessel's propeller and the propeller shaft and its bearings as well as the rudder were damaged. In addition to this, the aft part of the vessel's hull got a clear dent (Figures 13 and 14). After the propeller hit the bottom rock, it pulled out the propeller shaft while the vessel was moving forwards. The shaft came off from the thrust bearings, and its inner part, which was narrower in diameter, remained loose in the opening of the shaft tube. Water started to flow into the engine room through the shaft tube. The thrust bearings broke the cooling water pipes and the cooling water tank[19] started to empty. The lower part of the rudder blade became first partly loose, and it later fell to the bottom in its entirety[20].

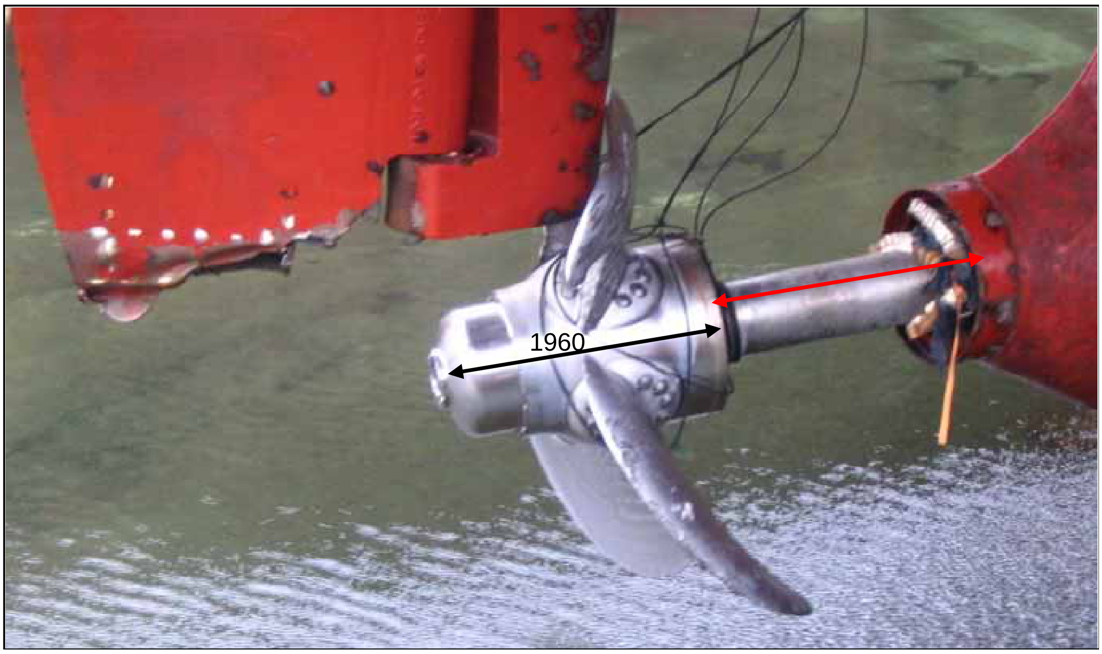


Figure 13. The damaged rudder, propeller and propeller shaft. The leakage gap has been filled. The propeller shaft bent and twisted. The propeller shaft had come out to the extent that it was about 90 mm thinner in the opening. (See Figure 19).

[19] Expansion tank.
[20] On the way from Jössingfjord to Stavanger.

Figure 14. The dent in the M/S TALI's bottom near the propeller and the rudder. There were no damages elsewhere in the bottom of the vessel.

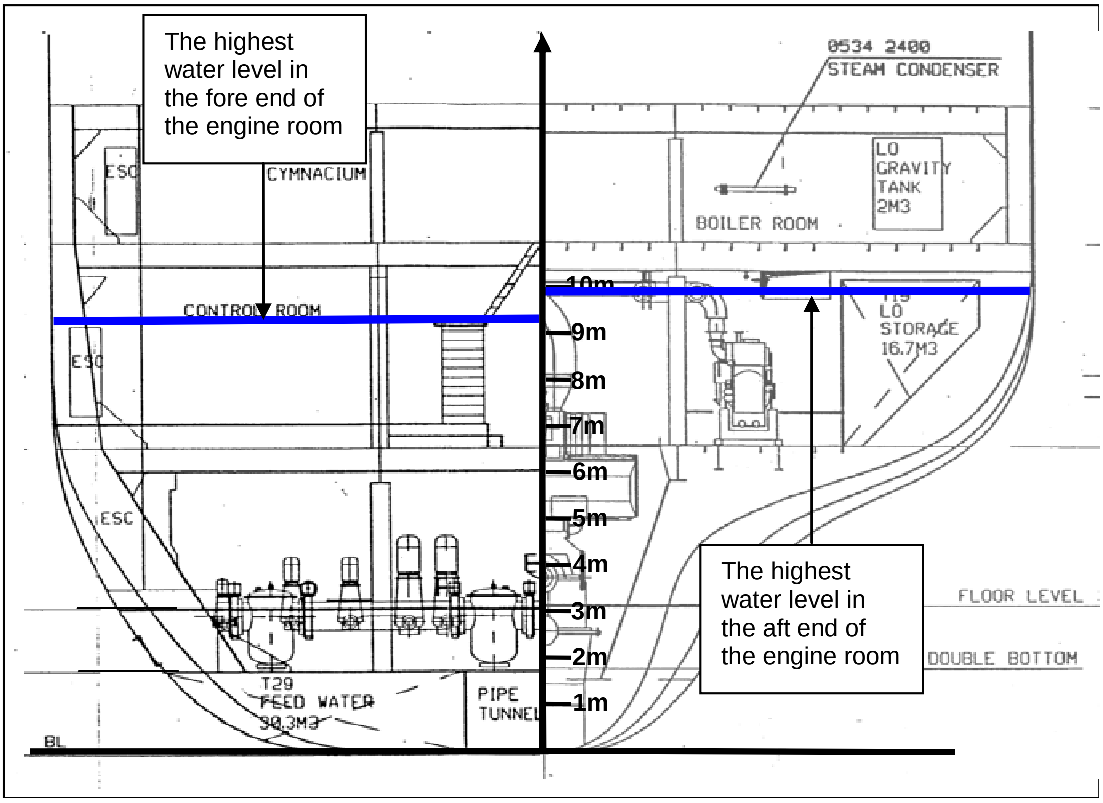


Figure 15. Water level in the aft part of the engine room. The water was about 50 cm lower in the forward part because of the vessel's trim.

The engine room equipment got damaged because of the water which flooded in. For example alarm and other cables had to be changed even in the dry areas because it was not possible to cut and join them. About 45 kilometres' length of different cables were renewed. All the engine room devices were fully overhauled and many of them were replaced by new ones.

1.3.8 Other damages

The vessel was out of traffic from 29 January to 21 July 2008.

1.3.9 Fire

There was no fire.

1.3.10 Navigation and communication equipment

M/S TALI had navigation equipment fulfilling rules and requirements. Additionally an electronic chart, Navisailor 3000 was in use. All equipment was in good shape and in use. The installation of the electronic chart had been left incomplete in the respect that the dimensions and shape of the vessel including the positions of the sensors were at the default values and the log was not connected.

On the wing of the bridge it was possible to control only the rudder, the main engine and the bow thruster. The use and observation of the navigation equipment presupposed that a navigator was present at the control console in the middle of the bridge.

For internal communication VHF-phones and wired telephones were used. The Master had a VHF-phone all the time. For external communication the vessel had equipment according to rules.

The navigation equipment had registered the following information.

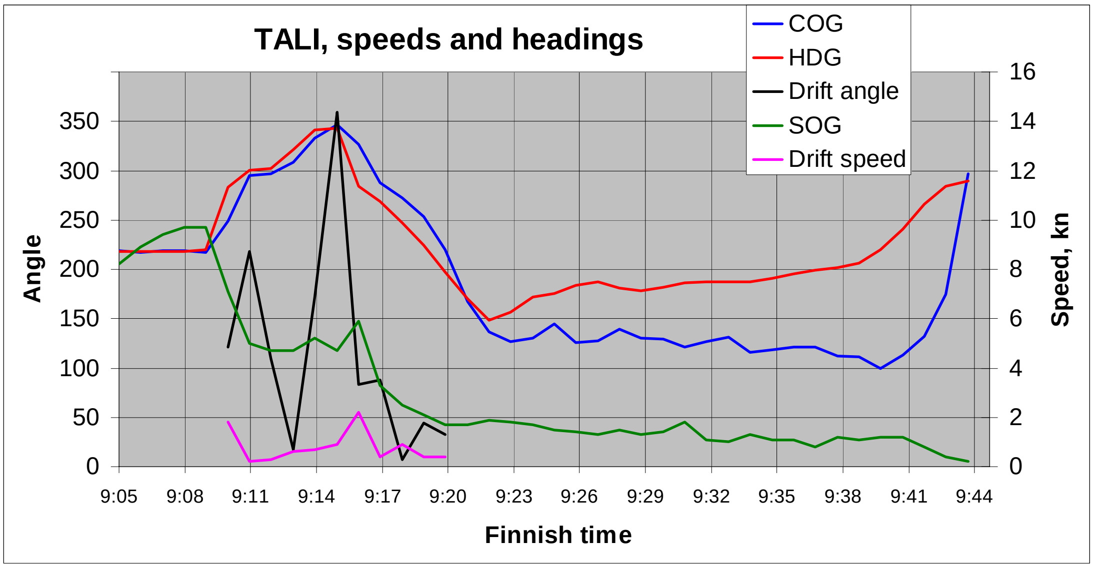


Figure 16. The vessel's speeds and headings at the time of the accident. Drift data is not accurate.

1.3.11 Registration equipment

Onboard there were electronic chart of Transas and a very simple voyage data recorder of type KIM. The information in these was for use to the investigation. The information was not perfect and the data was partly complicated to interpret. The data from the engines was in use as paper print format.

The KIM equipment had registered e.g. the following information, Figure 17.

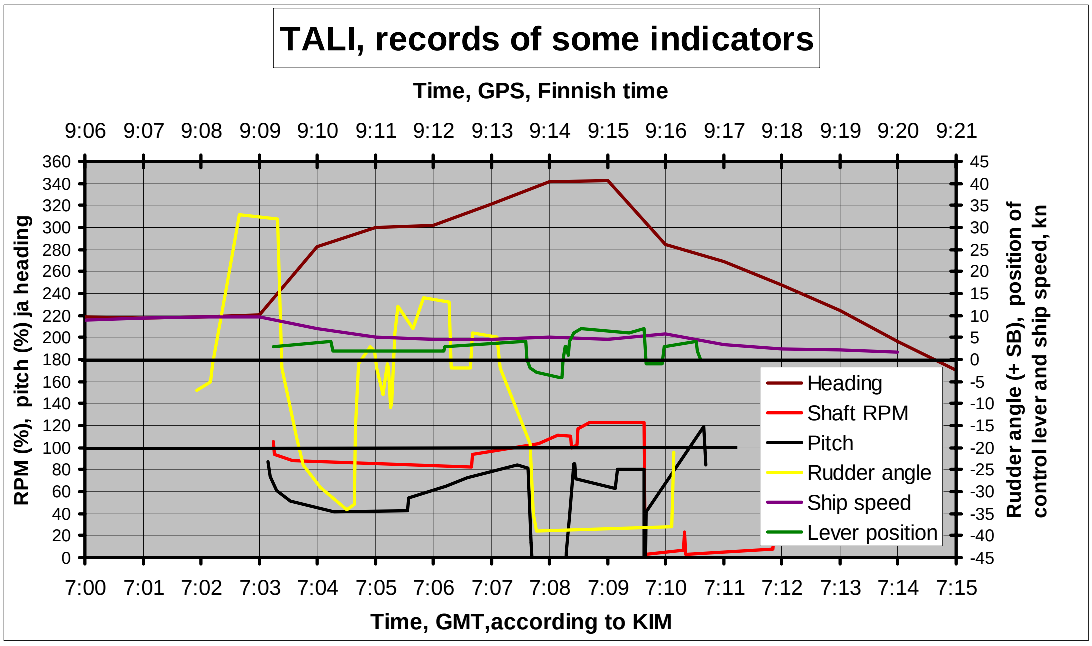


Figure 17. Registrations made by the KIM equipment at the time of the accident. Propeller revolutions in per cent (100% corresponds with the main engine revolutions 450 1/min). Here the time difference has been estimated to six minutes. The speed has been obtained from the GPS registration. At 9:09 the vessel turns away from the fiord. At 9:10–9:11 the course is stabilised at 300 degrees. At 9:11–9:13 more shelter from the wind, the vessel turns further. The turning of the rudder to port begins at 9:13. The rudder hard to port at 9:14–9:16.

1.3.12 The operation of the VTS and the supervision systems

There are no VTS services in the area.

1.3.13 The port and port equipment and fairway equipment

The Jössingfjord port is situated in the far end of the fjord. The port has a fixed conveyor for loading bulk cargo. This means that the vessel has to be moved under the conveyor in order to load all holds. The cargo has to be leveled and trimmed, too. The repeated moving of the vessel strains the crew to some extent. M/S TALI was berthed her starboard side to the quay, the bow towards the far end of the fjord. The loading went without any problems.

After leaving the quay the Master turned the bow towards the mouth of the fjord and sea. The water depth in the fjord is adequate up to the shore rocks with the exception of four shallows halfway to the sea.

At the mouth of the Jössingfjord, at both sides, there are sector lights Västra and Östra Kvalen. A little bit more into the fjord on both shores there are flicking lights. These lights are useful when approaching from the sea. To discern the mouth of the fjord visually might be difficult without the lights, which can be seen in a video obtained during the investigation showing the ship approaching the fjord. When leaving the port the lights are less helpful. The high rocks around the fjord give an excellent radar echo. However, the exact position of the vessel is difficult to determine with the help of the radar alone.

A distinctive feature of the maneuvering the vessel past the mouth of the fjord is the rapid change of the environmental conditions. After sailing only one ship's length, the vessel moves from protected fjord to practically unprotected open sea conditions.

In the investigation it has not been possible to clear if the route of vessels is reported somewhere and if it is possible to get any other information concerning the weather and sea conditions than collected by experience from weather observations and forecasts.

1.4 Rescue activities

1.4.1 Alerting activities

The pilot contacted the pilot vessel immediately after the grounding, and told her to inform Rogaland radio about what had happened and ask the coastguard for assistance.

1.4.2 The course of rescue activities

At 10:10 the rescue cruiser (SAR vessel) PETER HENRY von KOSS and at 10:15 the coastguard vessel LAFJORD (W317) arrived at the scene. It was decided that these vessels were to be used to try to tow M/S TALI to a safer place. The towing capacities were estimated to be adequate. The first pump was received from the SAR vessel at 10:32. The tugboat KHAN had also been ordered to the location; her estimated time of arrival was 13:30. At 10:40 M/S TALI's draught aft was 9.2 m, and it did not seem to be increasing. At 10:45 COS[21] arrived at the vessel.

At 10:47 the SAR vessel was fastened to the bow of M/S TALI and at 11:58 the LAFJORD was fastened to the stern. At 12:03 the portside anchor with its chains was dropped to the anchorage and the journey towards Jössingfjord was commenced by towing the vessel backwards. At this point it was noticed that the leakage had started again. At 12:37 two more pumps were received, likewise at 13:15 and at 13:30. Finally there were altogether seven pumps onboard M/S TALI. At 13:40 the tugboat KHAN arri-

[21] Commander On Scene, often also used in the form OSC, On-Scene Commander.

ved to the starboard side to assist. At 13:48 the LAFJORD let go the stern rope, which the tugboat KHAN took at 13:52. At 14:30 the tugboat disengaged and moved to the starboard side to assist in the mooring to the quay. At 15:00 M/S Tali moored to the loading quay assisted by the tugboat, the LAFJORD and the SAR vessel. At 15:30 the draught at the stern was about 10.8[22]m and at the bow 6.94 m.

The SAR vessel's divers examined the damages and blocked the leakage, and it was possible to start emptying the vessel. The Wärtsilä maintenance team arrived at the scene as early as 30 January. The rescue vessels stayed at the scene to guarantee safety. Generators were brought onboard the vessel on 1 February. The divers were still trying to stop the leakage on 2 February at 12 o'clock. Unloading the cargo to M/S PASILA was commenced in the evening of the same day. M/S PASILA had arrived to Jössingfjord and she had been fastened on the M/S TALI's starboard side at 16:00.

The rudder and the propeller of M/S TALI were fastened by welding and cables to prevent them from moving further. The unloading was completed in the evening of 4 February, and preparations were begun to tow the vessel to Stavanger. The towing started at 13:50 on 7 February, and the vessel arrived at the waiting quay of the Rosenberg dock after midnight on 8 February.

1.5 Completed special investigations

1.5.1 Investigations on the accident vessel and at the scene of the event

The investigators visited the vessel on 19–20 February 2008 and on 12–14 May 2008 while she was docked in Stavanger. The Master of the vessel was interviewed during the visits and also at offices of the Accident Investigation Board. The shipping company provided the investigators with the vessel's documentation. The representatives of the vessel and the shipping company cooperated in a successful way with the investigators.

1.5.2 Technical investigations

M/S TALI's technical voyage data recording devices i.e. the KIM recorder (S-VDR) and the electronic chart device TRANSAS had recorded data, the quality of which varied to a great extent.

It was possible to estimate the risk of sinking by examining vessel's drawings, the damages and the level of the seawater in the engine room.

1.5.3 The actions taken by the crew and the pilot

The bridge manning was normal at departure and during the pilotage. Nothing out of the ordinary happened before the pilot's suggestion to leave the vessel early. It is not exceptional for a pilot to leave a vessel on a sea area which can be considered to be open.

[22] Draught markings do not come up this far.

When the pilot left the bridge, the Officer of the Watch also left the bridge and only two persons remained there, i.e. the Master and the helmsman.

The Master and the pilot made no actual checks with reference to the pilot leaving the vessel and the vessel's safe navigation. The route plan was not followed as to the disembarkation of the pilot. The situation was routine. This had been done many times before. It is mandatory to use a pilot in Norway. The pilot suggested disembarking the vessel early from the point of view of his own convenience and possibly also of his own safety. The pilot knew that the Master was well familiar with the fairway from the mouth of the fiord to the sea.

1.5.4 Organization and management

A Safety Management System (SMS) in accordance with the ISM Code was employed on the vessel. Some of the documentation dated back to year 1998 when the vessel started to traffic. Many sections have been updated in the course of the years, and the latest update was made on 18 January 2007. The Designated Person Ashore (DPA) of the shipping company had been changed on 18 December 2007.

The actions taken after the accident were guided by the instructions of the Safety Management System which aims at guaranteeing human life, environment and property, and making notifications about the accident.

1.5.5 Other investigations

The effects of the weather conditions and currents in the area on the manoeuvring of the vessel

The **wind** could blow freely from west. The islands situated at the mouth of the fiord may have somewhat lessened the wind right at the mouth of the fiord. When the vessel was moving towards northwest, she no longer enjoyed the shelter given by the islands, and the wind blew at full force on the vessel's windage. According to Norrbin's[23] wind effect calculations, the side force at a wind speed of 10 m/s is approximately 8 tons. When the angle of attack is 50–130 degrees, the turning moment caused by wind is small.

Waves have two different effects. Firstly, they cause a translating force, which depends on the vessel's length and position with respect to the waves. Secondly, they generate the vessel's longitudinal, transverse and vertical movements, which can be evaluated by customary calculation methods based on the information of the sea state and the main dimensions of the vessel. The translating force F caused by the swell of the sea is calcu-

[23] Nils H Norrbin, Vindbelastningar på typfartyg i svenska farleder, Marintekniska Institutet SSPA, allmän rapport NR 62, 1984. The vessel type D0 is so similar with M/S TALI's type that available results can be used directly when it is taken into consideration that there are two deck cranes in the design vessel and three on the M/S TALI (this has been taken into account by increasing the effect of the wind by 5%). If another wind speed than 10 m/s is used, a proportional correction must be made to the square of wind speed. The angle of attack of the wind = 0, when the wind blows from the direction of the bow. The angle of attack has been defined on the basis of the relative direction of the wind. This fact bears no significance in this case because the vessel's speed was slow.

lated from the formula[24] $F = 0.35L\rho g(0.5H_{1/3})^2$, in which L stands for the length of the vessel's waterline, ρ for the density of water, g for the acceleration of gravitation and $H_{1/3}$ for the significant wave height. This results in 0.35 x 130 x 1000 x 9.81 x 1 x 1 N = 45.5 tons. If it is presumed that short waves as to their height correspond with one quarter, the result is 45.5 / 16 = 2.8 tons. Athwart sea also causes a mainly vertical heaving movement (in addition to rolling). The Bretscheider wave spectrum is used in the calculations. The significant wave height is then 2.5 m and the resonant period of the waves is 8 s. In athwart sea the response amplitude operator of the heave is mainly 1, but approximately 1.2 at the natural frequency of the heaving. When these suppositions are used, the amplitude of significant heaving is 1.2 m and the significant vertical velocity approximately 0.8 m. When the minor pitching is taken into account, the draught of the vessel's stern could temporarily increase approximately 2 m.

The effects of **currents** have been estimated to be minor. Tide changes in this area are small, Figure 7. Wind might have caused a current parallel with the shore, and the current might have somewhat decelerated the headway.

Evaluation the danger of sinking

The crew was able to estimate the effects of the leakage with the help of a theory documents folder containing damage stability calculations. The leakage turned out to be symmetrical, and the shell of the vessel did not suffer from leaking damages. The initial metacentric height had been approximately 4 m before the leakage. The crew could establish that there was no risk of sinking. The opinion on the vessel was, however, that obtaining pumping equipment was useful in trying to restrict damages. The flooding of the engine room and its significance with reference to the safety of the vessel has been dealt with in more detail in the section Analysis.

1.6 Rules, regulations and instructions guiding the operations

1.6.1 National legislation

On a Finnish (and also on a foreign) vessel the power of decision on the bridge lies with the Master or his stand-in. The pilot is the expert on the local conditions, and he/she has an educational and work history as a navigator. The pilot acts as the Master's *advisor*.

1.6.2 Regulatory decisions and instructions

In Norway it is mandatory for vessels engaged in merchant shipping to use an official pilot when arriving in or departing from ports. The Norwegian Coast Guard administers pilotage[25]. Vessels' Masters and other officers who have navigational qualifications have, however, the possibility to take a pilotage test for some fairways. A passed pilotage test gives the Master the Pilot Exemption Right (PEC)[26], which is valid if the Master sails the

[24] H. Hensen, Tug Use in Port, The Nautical Institute 1997, p. 77. The formula only applies to short waves. The result received from the formula must thus be reduced.
[25] Norwegian Coastal Administration (Kystverket).
[26] Pilot Exemption Certificate

route in question an adequate number of times annually. PEC is valid only for one vessel. The language skill requirement is a fluent Scandinavian language or English. The vessels of ESL Shipping visit Jössingfjord a couple of times every year. Because of the alternation systems and relatively few visits, the Masters do not have enough piloting annually in order for the possibly taken pilotage test to stay in force.

1.6.3 The operator's orders

Pilotage is dealt with in the ESL Shipping's ISM material in Part 2, Chapter 13, "Operations and Navigation". Bridge routines and route plans are dealt with under section 13.3. According to that section, the pilot must be given a Pilot Card, his/her actions must be followed, and if needed, it must be made certain that the pilot's intentions correspond with the route plan. Pilots must be asked to comment on route plans. However, route plans which are regularly in use do not need to be approved each time separately (a decision made by the Finnish Maritime Administration).[27]

For example the following is said in the section on the usage of various instruments: The Officer of the Watch must use the instruments available on the bridge regularly and contemporaneously with each other. As far as possible, the position of the vessel must be determined using various methods and instruments. The movements of the echoes shown on the radar must be compared with visual observations when the visibility allows this.

There are no special instructions with reference to pilot boarding situations. Referring to the previous paragraph, the role of the OOW remains unclear when he leaves the bridge in order to accompany the pilot. The manning of the bridge is then incomplete.

[27] The quotation is from the instruction, section ”route plan”.

2 ANALYSIS

The factors affecting the accident viewed with reference to the disembarkation of the pilot have been compiled in the following figure 18.

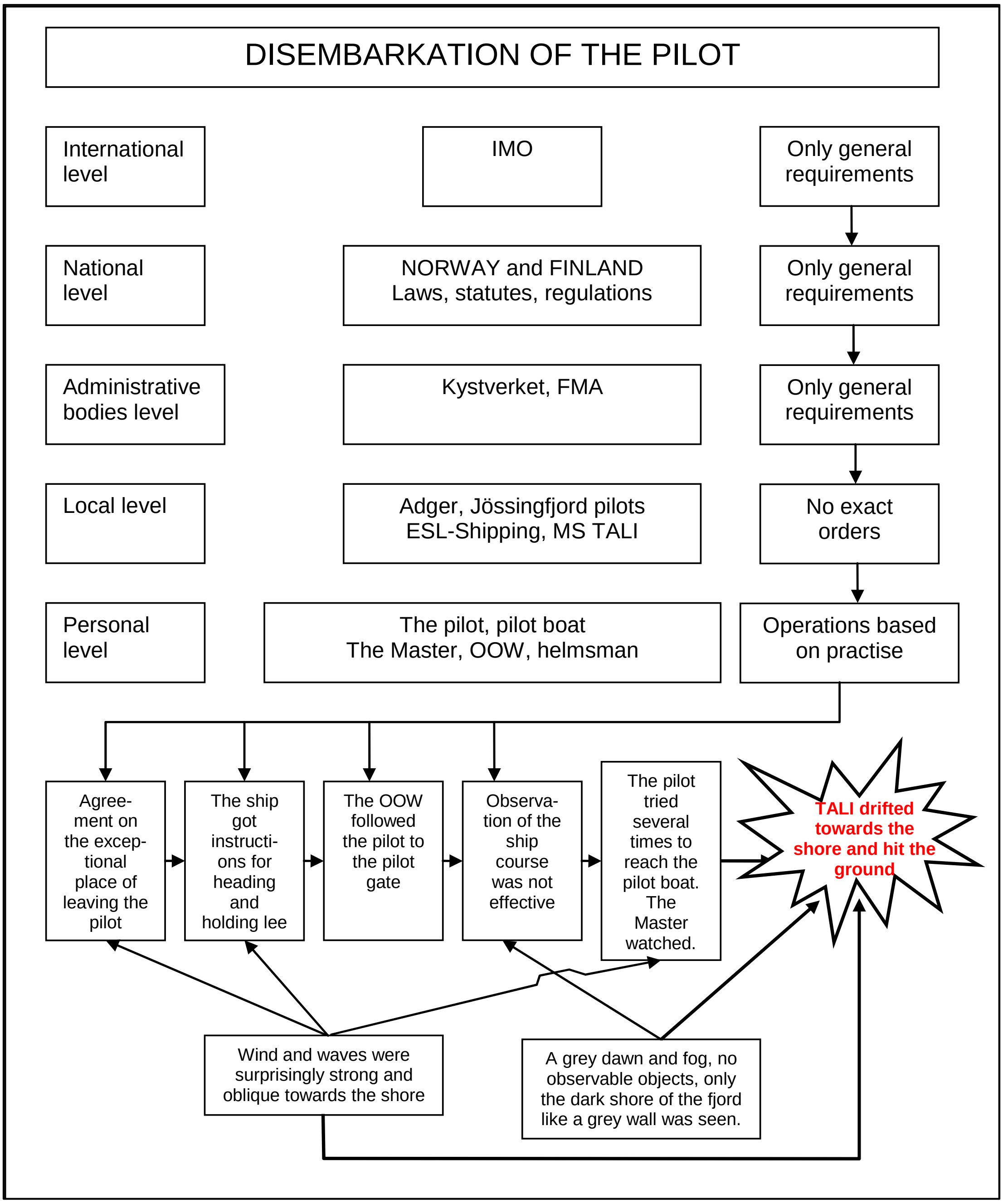


Figure 18. ACCIMAP scheme describing the accident. The disembarkation of the pilot.

2.1 Actions taken by the Master and the pilot

It is not unusual for a pilot to disembark a vessel elsewhere than at an official pilot boarding place. This often happens because of the circumstances. Sometimes the circumstances make is impossible for the pilot to leave the vessel at all and he/she has to stay on the vessel to the following port. This has also happened on M/S TALI.

In Jössingfjord the pilot had sometimes disembarked in the fiord area, just before the vessel reaches the sea. This time there was no discussion about the sea conditions when inside the fiord, and the pilot did not come forth with the idea of disembarking until the vessel had reached the sea. The Master agreed with the suggestion, and when leaving the bridge, the pilot gave an instruction to make a lee for the pilot vessel in the swell of the sea. The situation was not considered to be that exceptional, the environment and circumstances were not assessed together but the actions were based on mutual confidence that there were not any problems.

The Master did not consider the information given by Transas-system completely reliable. The erroneous information was based on wrong location of the position sensor relative to ships dimensions. Additionally Transas-system gave erroneous drift data because the log was not connected to it.

Because of the sea, the heaving motion of the pilot vessel was so substantial that it was not possible for the pilot to board the pilot vessel in spite of several attempts. The Master was concentrating on the pilot vessel and the pilot's attempts to leave M/S TALI. It is the investigators' opinion that disembarking the pilot was attempted for too long although the swell of the sea proved to be too heavy. The Master observed the pilot vessel and the situation, and did not notice that the vessel was getting very close to the shore.

It was difficult to estimate the distance because of the dawn and the poor visibility of the shore in the morning mist. There were also no lights or marks on the shore, which the Master could have used in estimating the vessel's position when standing on the bridge wing.

The drift caused by athwart sea and wind was apparently not taken properly into consideration when anticipating the vessel's movements.

After the pilot and the officer had left, there were only two persons on the bridge, i.e. the Master and the helmsman. Both of them were paying attention to one thing respectively: the Master was observing the disembarkation of the pilot and the helmsman concentrated on listening to the Master's instructions and on the rudder. Enough attention was not paid to observing the vessel's position.

One more person would have been needed to continuously monitor on radars and visually how the vessel proceeded. The shipping company had not given instructions with reference to pilot boarding situations.

2.2 The grounding

The pilot had given 285–290 as the course, but also asked for leeway when necessary. According to what the Master remembers, 300 degrees was supposed to be the course.

When the pilot left the bridge to go down to the pilot gate, it was obviously not completely unambiguous how the disembarking of the pilot was going to be carried out. Soon after the helm order given by the pilot, the Master moved to the manoeuvring place located on the starboard wing. From there he could observe the pilot's attempts to disembark and wave goodbye to the pilot.

According to what the Master remembers, he ended up making better lee by using the helm order "five to starboard". The synchronised[28] recording from the KIM recorder shows that three minutes before the helm order in question was given, the rudder had been more than 10 degrees to starboard for several minutes, then midships for a short time, and after that 5 degrees to starboard for half a minute. The vessel had then turned to course 324. After the Master had noticed that the vessel was approaching the shore in an alarming way, he ordered "hard to port" and switched on the bow thruster after that. The Master let the engine run "full astern" for about ½ minute at about 9:14 (Figure 17, the position of the lever, the green curve). Because of the vessel's inertia and the effects of the wind and the swell of the sea, the vessel turned to course 343 before it started to turn towards port. At that point the vessel had already come very close to the shore. It took about two minutes from the moment the rudder started to turn "hard to port" for the vessel to begin the turning. After the turn had started, the stern of the vessel moved even closer to the shore. At the same time the vertical movements of the vessel contributed to its stern hitting the ground.

An extra 25–30-degree turn to 324 degrees had happened because the Master did not have reference of the turning movement due to poor visibility and because he was not at his normal manoeuvring place where he would have noticed the turn on the radar. At the manoeuvring place on the wing there are only control devices for the main engine and the bow thruster, not information received from navigational or position plotting instruments. The visibility from the manoeuvring place is reduced by a folding console cover (Figure 3).

In addition to the facts mentioned earlier, the manoeuvring of the M/S TALI was impeded by athwart sea, which might have turned heavier after the vessel exited the shelter given by the islands. The forces generated by wind and sea caused the vessel to drift towards the shore[29]. The vessel has inertia when turning, and the speed was slow, about 5 knots, which means that the manoeuvring forces of the rudder were correspondingly small.

It has been assessed based on Figure 12 that the stern of the vessel had, when turning and proceeding forwards, hit a rock or a hillock sideways. Apparently the bottom was uneven or rocky, and M/S TALI hit one or several protuberances while the stern of the

[28] The times of the recording were moved six minutes so that they would indicate the events. The recording cannot be considered qualitative to all parts.

[29] The estimate of the drift can be calculated e.g. as follows. The moving force (wind + waves) is about 130 kN. Acceleration 130/20000 = 0.0065 m/s^2. In one minute the drift is then 0.5 x 0.0065 x 60^2 = 11.7 m and the transition speed after one minute 60 x 0.0065 = 0.39 m/s. Upon the increase of the transition speed, the lateral resistance grows. A conservative estimate of the net effect is that the vessel moves 5 m/min. In five minutes the transition based on these suppositions is 25 m, which is significant when the proximity of the shore is taken into account. It is realistic to estimate that in the prevailing circumstances the vessel could move tens of metres sideways towards the shore in athwart sea and the swell of the sea.

vessel was moving up and down because of the heaving and pitching movements. As a result, she did not stay aground.

First the aft part of the hull and then the propeller hit a rock, and due to the vessel's big mass, the shaft came loose from its thrust bearings and protruded until it stopped when the propeller hit the rudder and the SKF coupling hit the shaft tube. The rudder also hit the bottom and got damaged.

Only the aft of the vessel hit the bottom. If the vessel had stayed only a couple of metres further away from the shore, the grounding could probably have been prevented. On the other hand, if the vessel had been a couple of metres closer to the shore, the shell of the vessel might have been broken and several compartments flooded. The consequences of this would have been the capsizing and sinking of the vessel.

2.3 The risks caused by the situation

The vessel was not in any risk of sinking or capsizing because the leakage was limited to the gap of the shaft tube. The engine room was flooded up to a little less than 10 m, and the water level stayed about 40 cm lower than the sea level. Onboard the vessel, there were damage stability calculations on loading conditions, in which the engine room had been flooded with water. Appendices 6 and 7 describe a loading condition, in which the flooding reduced the initial metacentric height from 0.85 m to 0.68 m. According to the investigators' estimate, the initial metacentric height could have decreased approximately 0.5 m during the time the engine room made water. In the loading condition prevailing at the time of the accident, the initial metacentric height was approximately 4 m according to Appendices 3–5. The stability remained good and the vessel did not have a list, because the water volume of the engine room was balanced enough with reference to port/starboard. Therefore the vessel was not in any danger of capsizing or sinking.

According to a calculation made on the vessel, there were 1,806[30] tons of water in the engine room (1,771 m^3 as the density of sea water is 1,0195 t/m^3) when the draught forward was 6.90 m and the draught aft was 10.58 m. The hull of the vessel had a bend upwards (the so-called hogging situation), and because of this the mean draught calculated on the basis of the draughts forward and aft differed from the draught which was observed midships. The difference was 15.7 cm. Displacement had been calculated to be 20,005 tons; the stern trim was 3.68 m[31].

The capacities of the pumps which were brought onboard the vessel have been estimated on the basis of the information about corresponding portable pumps. The estimate is approximately 0.6 m^3/min. Altogether seven pumps were brought onboard the vessel. Without these pumps the vessel's situation would have corresponded with the damage stability calculations in which the engine room had been flooded. In that case the vessel's draught aft would have been approximately 0.5 m more, but the vessel still would not have been in any risk of capsizing or sinking.

[30] This is probably the maximum amount of water.
[31] Appendix 8.

According to the observations made onboard M/S TALI, she did not make water or made only some water 10:40–12:00. The crew have not had any clear explanation for this. The investigation has also not been able to find out the reason. It is possible that the rising of the water had brought along an object which blocked the opening. The outlet of air might have become more difficult at times. The inaccuracy of the observations may also partly explain the situation. The rising of the water starts to slow down at a height of approximately 6m from the base line, because the engine room gets significantly wider at that point and the main engine starts to make water. When the towing was then commenced backwards, the flow from the opening of the propeller shaft grew stronger and the possible obstacle came loose.

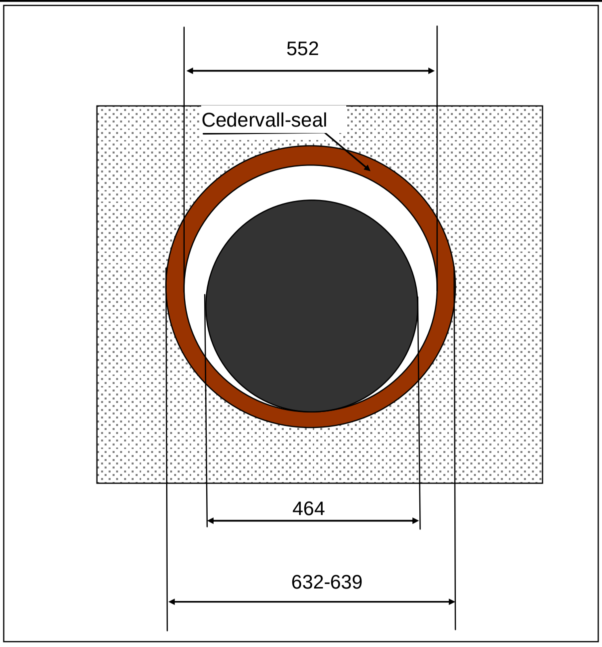


Figure 19. The leakage gap. The measurements are expressed in millimetres. The immediate area next to the opening was cast steel, indicated by grey colour in the picture.

The maximum value of the in-flow speed of water is estimated based on a known formula[32]; the flow of water through a small opening with a pressure head h. The water level observations made on M/S TALI set the boundary conditions. The in-flow area of the leakage gap (Figure 19) was approximately 700 cm^2. The gap developed when the propeller shaft protruded. The outward movement stopped when the propeller hit the rudder and the SKF coupling hit the shaft tube (Figure 4).

In reality the flow has passed through a long tube having a narrow sickle-formed cross section and there have been obstacles in its inner end, e.g. the broken SKF coupling. The calculated maximum volume flow is approximately 44,4 m^3/min during the first minutes of the leakage. In the investigation approximately 20 m^3/min has been estimated to be a realistic value because of the pipe friction and the choking effect of the broken SKF

[32] v = square root (2 x g x h), in which g stands for the acceleration of gravity (= 9.81 m/s^2) and h for pressure height in metres and v for velocity m/s.

coupling at the bow end of the shaft tube. The results of the calculations have been presented in Figure 20. The point for the decreasing and recommencing of the flow has been somewhat rounded in the calculations.

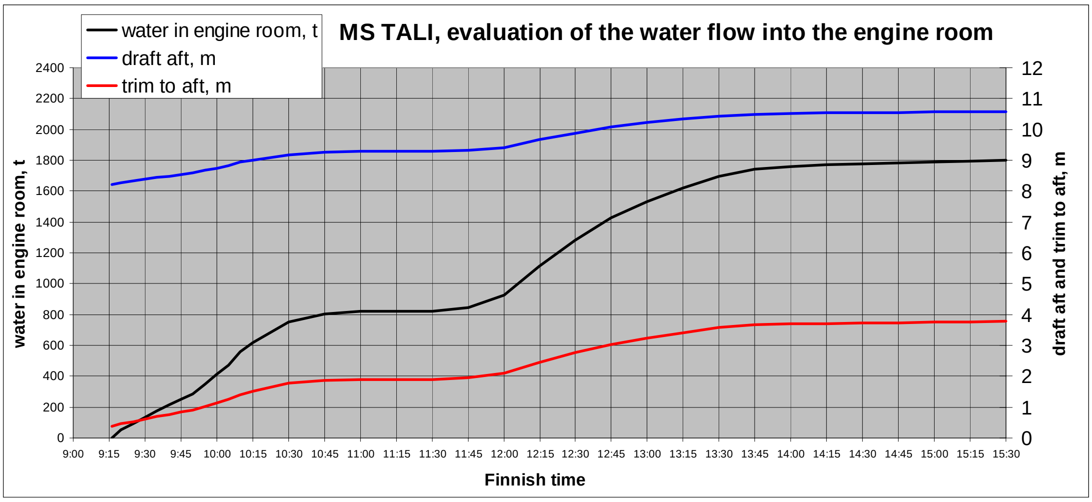


Figure 20. An estimate on the flooding of the engine room.

The vessel was successfully turned before its bow or side hit the shore. Based on the calculated loading conditions presented in the vessel's damage stability calculation folder[33], the vessel would not have managed without capsizing if it had had additional side leakages, if the initial metacentric height had been clearly smaller than in the accident event. The situation would be more complicated when the vessel is carrying ore. The vessel would not capsize immediately due to the side leakage, but it would heel, and the flooding of the engine room would continue to a higher level. In that case the heel would increase and sinking would continue, and shifting of the cargo might become possible. The sea bottom is probably very steep (Figure 21), and the vessel would not have stayed upright if it had remained fast on the ground. In addition to this, wind and sea would have pushed the vessel to the shore, and this would have caused further damages to the plating. These potential risk factors have not been assessed in further detail.

If the bow thruster had been damaged or stopped abruptly, the wind and sea would have pushed the vessel to the shore followed by the above-mentioned consequences. The vessel was saved by the fact that her turn had been started before she hit the shore. The stern did not hit the shore until during the turn, and the vessel continued moving away from the shore because of her inertia and thanks to the bow thruster. According to the investigators' view the vessel was turned in the last minute.

[33] In these cases GM has usually been less than a metre when the vessel has had full draught. When ore is carried, the GM is approximately 4 m, and these kinds of damage stability calculations have not been made.

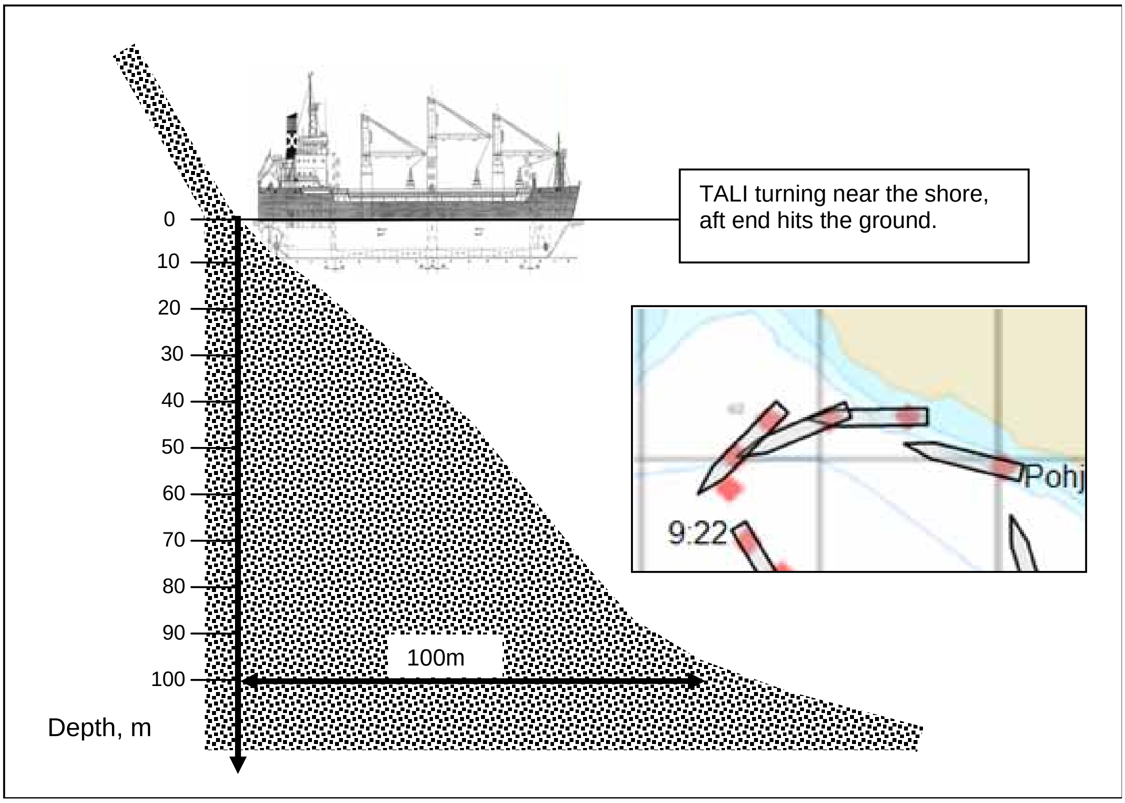


Figure 21. M/S TALI hits the shore. The steepness of the shore has been estimated based on the depth curves in the chart extract; the shallowest is 10 m, the following one 20 m and the third one 100 m.

The vessel did not heel and the trim was not extensive, so it is assessed that the cargo was in no danger of shifting.

2.4 Rescue activities

The pilot raised the alarm immediately and help was received quickly. The flooding of the water was so heavy that it was not possible for the vessel's crew to stop the leakage. The estimated volume flow in the beginning was about 20 m^3/min. The maximum capacity of the vessel's pumps for draining the water was theoretically approximately 450 m^3/h, i.e. 7,5 m^3/min for draining the water, so the crew could only try to restrict the damages. The crew took the necessary measures, e.g. the tanks were sounded for discovering possible leakages, the stability of the vessel was checked, preparations for anchoring were made and the state of the machineries was monitored.

It seems that the cooperation between the vessel and the rescue personnel was exemplary. Getting the vessel away from the proximity of the shore and to anchor was successful. The vessel was also towed to the quay quite soon, and the leakage was stopped. The engines received some first aid, and the supplier of the devices was immediately called for.

2.5 Synchronizing times

Two time scales have been presented in Figure 17. KIM follows UTC time, and the upper scale represents Finnish winter time (UTC+2). The KIM time seems to be 5½–6 minutes behind. In the figure, six minutes has been chosen as the difference. The difference in time has been deduced from the grounding taking place just before 9:16. The vessel was turning to port, the heading-angle started to decrease. At the same time the curves for the pitch and revolutions fall sharply. The rudder angle changes abruptly a little bit later.

The time expressed by KIM is unreliable if it is not synchronized often enough. It had probably not been synchronized for a long time.

According to a print there was an alarm in the engine room at 9:14:45. According to the GPS information, the vessel was at the time not yet close enough to the shore for a grounding to take place. According to the GPS information, the grounding could have happened somewhat before 9:16. Therefore the investigators presume that the engine room clock had been approximately one minute behind the GPS time. Thus a minute must be added to the engine room times.

The times in the ship's logbook and the engine logbook are congruent. One minute must thus be added to the times written in the logbooks.

2.6 Other safety observations

The pilot vessel did not try to interrupt the situation earlier even though there was a risk of it being squeezed between M/S TALI and the shore.

The visibility and communications between the bridge and the pilot gate could be improved by video monitoring and direct speech contact.

When designing vessels, it would be advisable to reflect on which point in the propeller shaft line should be the weakest against an outwards-pulling force. Should the propeller come loose in a corresponding situation before the shaft comes loose, in which case there is no leakage and the rudder may remain functional? In the case of the M/S TALI, the propeller withstood the outward-pulling force in such a way that the propeller shaft moved out and water could freely flood into the engine room.

Nowadays it is possible to get a forecasting display for the combined display of an electronic chart and a radar display; this is called a predictor. In the M/S TALI's case having such a display on the manoeuvring place on the bridge wing would have warned the Master in good time, and the disembarkation of the pilot would have been interrupted earlier.

In year 2007 252 piloted vessels entered Jössingfjord. According to what the pilot remembers, there have been three accidents in 20 years. In these cases there was not a pilot on the vessel.

It would have been safest to leave the pilot already at the mouth of or inside the fiord. The pilot vessel could guide the vessel ahead of it if manoeuvring assistance was required. After the fiord there is enough space to manoeuvre using sufficient engine power without running the risk of grounding, and the pilot is no longer required.

The officers' state of alertness might have been affected negatively by the loading operation, which started immediately after the arrival and went on throughout the night, and by departing immediately after it in the morning on 29 January 2008.

3 CONCLUSIONS

3.1 Findings

The vessel's departure and pilotage went as usual. The pilot asked, however, to disembark the vessel in a location differing from the ordinary one. This was nevertheless not unusual. Visibility was reduced by dawn, cloudiness and mist.

3.2 The causes and underlying factors of the incident

The pilot's boarding of the pilot vessel was prolonged, and M/S TALI drifted too close to the shore. In the morning dawn the shore was visible only as a dark wall, and because of this the proximity of the shore was noticed too late. There was visibility from the bridge only to the pilot vessel; the pilot and the pilot gate could not be seen from the bridge or the bridge wing.

The wind and the swell of sea pushed the vessel towards the shore, and this factor had not been taken into consideration from the beginning when manoeuvring the vessel. The wind and the swell of sea also slowed down turning away from the shore.

There were no special instructions with reference to a pilot leaving a vessel neither at the shipping company nor on the vessel.

3.3 Additional safety findings

Updating the earlier in 2.1 mentioned shortcomings of the Transas-system, would increase the navigators' trust to the information produced by the system.

4 THE IMPLEMENTED CORRECTING MEASURES

Norway Pilot has informed that it will check pilot boarding procedures in the area in question and in the whole Adger traffic area[34].

The shipowner has announced to have updated their SMS-manuals regarding embarking and disembarking of pilot as well as navigation in restricted fairways. These emphasize the adequate manning of the bridge at all situations.

[34] Prosedyre 4-05 A 31.1.2008 of the Coast Guard; it also includes the pilot's report on the incident.

5 RECOMMENDATIONS

The investigators do not give any recommendations because the shipowner has taken corrective measures.

Helsinki 4th of February 2009

Risto Repo | Olavi Huuska | Karl Loveson

LIST OF SOURCES

The sources mentioned in the Report are stored at the Accident Investigation Board

Appendix 1. Alarm printout

ALARM LIST for TALI — NORCONTROL AUTOMATION A/S — DC2000

Date	Time	Tagname	Tag description	Func	Value	Alarm
08-01-28	23:02:10	XA7332	OIL-FIRED BOILER NON CRITIC FAIL	XA	OPEN	ALARM
08-01-28	23:04:24	XA7332	OIL-FIRED BOILER NON CRITIC FAIL	XA	OPEN	RETURN
08-01-28	23:11:56	PI7302	BOILER STEEM PRESS	PI	LOW	ALARM
08-01-28	23:28:53	PI7302	BOILER STEEM PRESS	PI	LOW	RETURN
08-01-29	07:49:59	PIAL2701	RED GEAR LO PRESS	1/98	LOW	RETURN
08-01-29	09:14:45	TIAH2802	STERN TUBE ASTERN BEAR. TEMP	TIAH	IFH	ALARM
08-01-29	09:14:45	TIAH2801	SHAFT LINE BEARING TEMP	TIAH	IFH	ALARM
08-01-29	09:14:45	XA2950	CP PROP. CONTROL SYST. FAILURE	XA	OPEN	ALARM
08-01-29	09:14:48	XA2952	CP PROP. TRANSMITTER FAILURE	XA	OPEN	ALARM
08-01-29	09:14:52	PIAL5204	DG2 LT WATER PRESS	PIAL	LOW	ALARM
08-01-29	09:15:37	UA7931	STEER. GEAR UNIT 1 COMMON ALARM	UA	OPEN	ALARM
08 -29	09:16:07	PIAL5304	DG3 LT WATER PRESS	PIAL	LOW	ALARM
08-01-29	09:16:12	LAL6431	EXPANSION TANK WATER LEVEL	LAH	OPEN	ALARM
08-01-29	09:16:34	ME LT CW2	ME LT CW PUMP NO.2	2/ 10	STBYST	ALARM
08-01-29	09:16:39	PIAL1101	ME HT WATER INLET PRESS	PIAL	LOW	ALARM
08-01-29	09:16:39	PIAL5302	DG3 HT WATER PRESS	PIAL	LOW	ALARM
08-01-29	09:16:41	PIAL5202	DG2 HT WATER PRESS	PIAL	LOW	ALARM
08-01-29	09:16:52	PIAL5104	DG1 LT WATER PRESS	PIAL	IFL	ALARM
08-01-29	09:17:09	LAH6239	BILGE ALARM MACHIN.ROOM #19 CL	LAH	OPEN	ALARM
08-01-29	09:17:21	PIAL5104	DG1 LT WATER PRESS	PIAL	IFL	RETURN
08-01-29	09:17:29	ME LT CW2	ME LT CW PUMP NO.2	2/ 10	STBYST	RETURN
08-01-29	09:17:41	PIAL5104	DG1 LT WATER PRESS	PIAL	IFL	ALARM
08-01-29	09:17:43	PIAL5104	DG1 LT WATER PRESS	PIAL	IFL	RETURN
08-01-29	09:17:46	LAH6238	BILGE ALARM MACHIN.ROOM #42 SB	LAH	OPEN	ALARM
08-01-29	09:17:51	LAL2935	CP PROP. MAIN TANK OIL LEVEL	LAL	OPEN	ALARM
08-01-29	09:17:59	PIAL5104	DG1 LT WATER PRESS	PIAL	IFL	ALARM
08-01-29	09:18:04	PIAL5104	DG1 LT WATER PRESS	PIAL	IFL	RETURN
08-01-29	09:18:11	PIAL5104	DG1 LT WATER PRESS	PIAL	IFL	ALARM
08-01-29	09:18:19	PIAL5104	DG1 LT WATER PRESS	PIAL	IFL	RETURN
08-01-29	09:19:18	LAH6238	BILGE ALARM MACHIN.ROOM #42 SB	LAH	OPEN	RETURN
08 -29	09:19:25	CEN.COOL.2	CENTRAL COOLING SW. PUMP NO.2	2/ 4	NO-STB	ALARM
08-01-29	09:19:30	TIAH5215	DG2 CHARGE AIR TEMP	TIAH	HIGH	ALARM
08-01-29	09:19:35	LAH6238	BILGE ALARM MACHIN.ROOM #42 SB	LAH	OPEN	ALARM
08-01-29	09:19:48	TIAH5315	DG3 CHARGE AIR TEMP	TIAH	HIGH	ALARM
08-01-29	09:19:53	LAH6237	BILGE ALARM MACHIN.ROOM #42 BB	LAH	OPEN	ALARM
08-01-29	09:20:02	TIAH5203	DG2 HT WATER TEMP AFTER ENGINE	TIAH	HIGH	ALARM
08-01-29	09:20:02	TIAH5312	DG3 LO TEMP	TIAH	HIGH	ALARM
08-01-29	09:20:08	TIAH5303	DG3 HT WATER TEMP AFTER ENGINE	TIAH	HIGH	ALARM
08-01-29	09:20:10	TIAH5212	DG2 LO TEMP	TIAH	HIGH	ALARM
08-01-29	09:20:27	TIAH5303	DG3 HT WATER TEMP AFTER ENGINE	TIAH	HIGH	RETURN
08-01-29	09:21:24	TIAH5303	DG3 HT WATER TEMP AFTER ENGINE	TIAH	HIGH	ALARM
08-01-29	09:21:55	PIAL1104	ME LT WATER INLET PRESS	PIAL	LOW	ALARM
08-01-29	09:22:07	TZH5281	DG2 HT WATER TEMP SHD	TZH	HIGH	ALARM
08-01-29	09:22:17	EI5240F	DG2 FREQUENCY	EI	LOW	ALARM
08-01-29	09:22:20	EI5240	DG2 VOLTAGE	EI	LOW	ALARM
08-01-29	09:22:25	PIAL5211	DG2 LO PRESS BEFORE ENGINE	PIAL	LOW	ALARM
08-01-29	09:22:27	PIAL5104	DG1 LT WATER PRESS	PIAL	LOW	ALARM
08-01-29	09:22:27	PIAL5102	DG1 HT WATER PRESS	PIAL	LOW	ALARM
08-01-29	09:22:30	PIAL1101	ME HT WATER INLET PRESS	PIAL	LOW	RETURN
08-01-29	09:22:30	PIAL1104	ME LT WATER INLET PRESS	PIAL	LOW	RETURN
08-01-29	09:22:30	EI5240F	DG2 FREQUENCY	EI	LOW	RETURN
08-01-29	09:22:30	EI5240	DG2 VOLTAGE	EI	LOW	RETURN
08-01-29	09:22:32	PIAL5211	DG2 LO PRESS BEFORE ENGINE	PIAL	LOW	RETURN
08-01-29	09:22:32	PIAL5204	DG2 LT WATER PRESS	PIAL	LOW	RETURN
08-01-29	09:22:32	PIAL5202	DG2 HT WATER PRESS	PIAL	LOW	RETURN

Appendix 2 Mate's receipt

M/S TALI MATE´S RECEIPT voy 804.08/08

Jössingfjord to Tahkoluoto

Arrival	28.01.2008	klo.	1630 lt.	Port density	1,0200
Loading	commenced	28.1.2008	1700 lt.		
	completed	29.1.2008	0635 lt.		

Stores/constant	40	Drafts	fore	7,839 m
FW.	53		L/2	8,063 m
Tech.W	19		aft	8,208 m
Sludge	14		M/M	8,053 m
Bilge	5			
HFO.	111			
DO.	27			
LO.	16			
Ballast	27			
Weights	312			

Displacement	18199
Light ship	5338
DWT	12861
Weights	312
CARGO	**12549 tn**

Jössingfjord 29.01.2008
Place and date

chief officer

Appendix 3 Load condition at departure

FINNYARDS RAUMA

LOADING CONDITIONS PAGE 60

LOADING CONDITION ORE, DEPARTURE, LOADING CASE IN ORE CONDITION

LOADING COMPONENTS

Name		Max. weight	Mass	Center of gravity cgx	cgy	cgz	Free s. moment
BALLAST WATER, RHO= 1.025							
T3S	.	736.2	80.0	100.63	4.61	0.22	1589.1
MISCELLANEOUS, RHO= 1.000							
S13	COOLING WATE	107.4	14.0	6.55	0.00	2.30	0.4
T21	SLUDGE TANK	29.3	8.0	20.71	2.69	0.39	17.0
Total of MISCELLANEOUS		136.7	22.0	11.70	0.98	1.61	17.5
LUBRICATING OIL, RHO= 0.900							
T19	LO STORAGE	14.3	14.0	11.40	7.84	8.92	4.8
T20	CIRCULATING	12.5	11.0	18.00	0.00	1.22	2.6
Total of LUBRICATING OIL		26.8	25.0	14.30	4.39	5.53	7.4
FRESH WATER, RHO= 1.000							
T18	POTABLE WATE	25.8	25.0	15.30	7.50	12.01	18.2
T18A	POTABLE WATE	31.0	25.0	18.60	7.50	11.84	21.8
T16	TECH. WATER	15.5	6.0	21.30	7.50	11.40	10.9
T29	FEED WATER	28.6	10.0	24.68	-3.72	0.41	32.4
Total of FRESH WATER		100.9	66.0	18.52	5.80	10.14	83.3
HEAVY FUEL OIL, RHO= 0.950							
T11	SETTLING TAN	38.1	38.1	16.80	7.93	8.67	10.1
T12	SETTLING TAN	25.9	25.9	20.70	8.03	8.58	6.3
T13	DAY TANK	31.1	31.1	24.00	8.03	8.58	7.5
T5S	STORAGE MID	298.0	54.9	69.49	4.45	2.61	218.0
Total of HEAVY FUEL OIL		393.1	150.0	38.27	6.69	6.42	241.9
DIESEL OIL, RHO= 0.850							
T17	DO STORAGE	63.4	30.0	27.31	5.04	3.40	42.8
CARGO							
HOLD-1		0.0	6490.0	91.31	0.00	3.73	0.0
HOLD-2		0.0	6400.0	48.00	0.00	3.73	0.0
Total of CARGO		0.0	12890.0	69.81	0.00	3.73	0.0
STORES							
AFT		0.0	20.0	18.00	0.00	15.00	0.0
FORE		0.0	90.0	121.80	0.00	15.00	0.0
Total of STORES		0.0	110.0	102.93	0.00	15.00	0.0

FINNYARDS RAUMA

LOADING CONDITIONS PAGE 61

Name	Max. weight	Mass	Center of gravity cgx	cgy	cgz	Free s. moment
CREW						
(CREW)	0.0	5.0	18.00	0.00	18.00	0.0
Deadweight		13378.0	69.34	0.15	3.87	1981.8
Lightweight		5311.0	56.92	-0.43	8.95	
Displacement (rho=1.025)		18689.0	65.81	-0.01	5.31	1981.8

FLOATING POSITION

Draught moulded	8.190	m	KM	9.52	m
Trim	-0.214	m	KG	5.31	m
TA	8.297	m	GMO	4.21	m
TF	8.083	m	GMCORR	-0.11	m
Trimming moment	-5609	tonm	GM	4.10	m

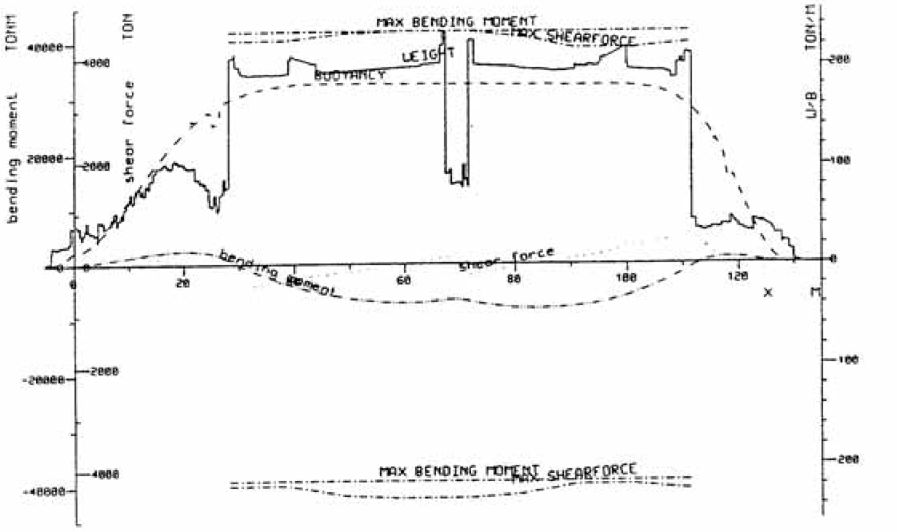
NOTE.: Pages 60 and 61 combined

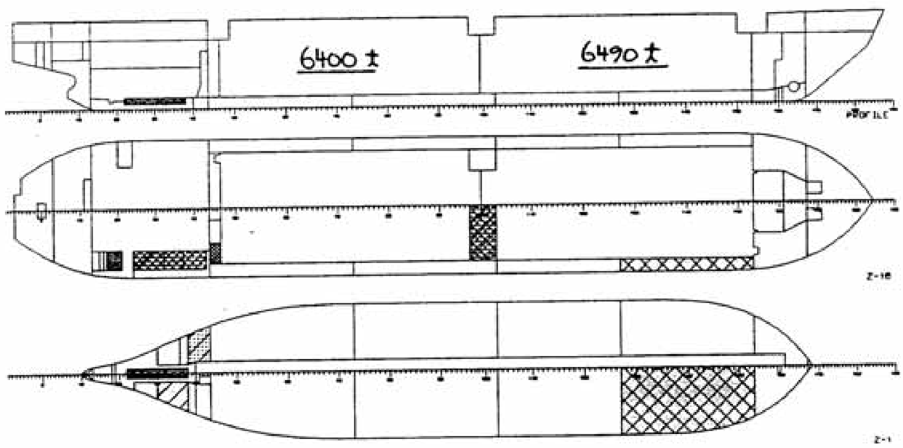
Appendix 4 Load condition, strength

FINNYARDS RAUMA *LOADING CONDITIONS* *PAGE* 62

STRENGTH CURVES

PROJECT	L409/A
DATE	95-12-18
CONDITION	ORE
DISP	18689 TON
DRAUGHT	8.19 M
TRIM	-0.21





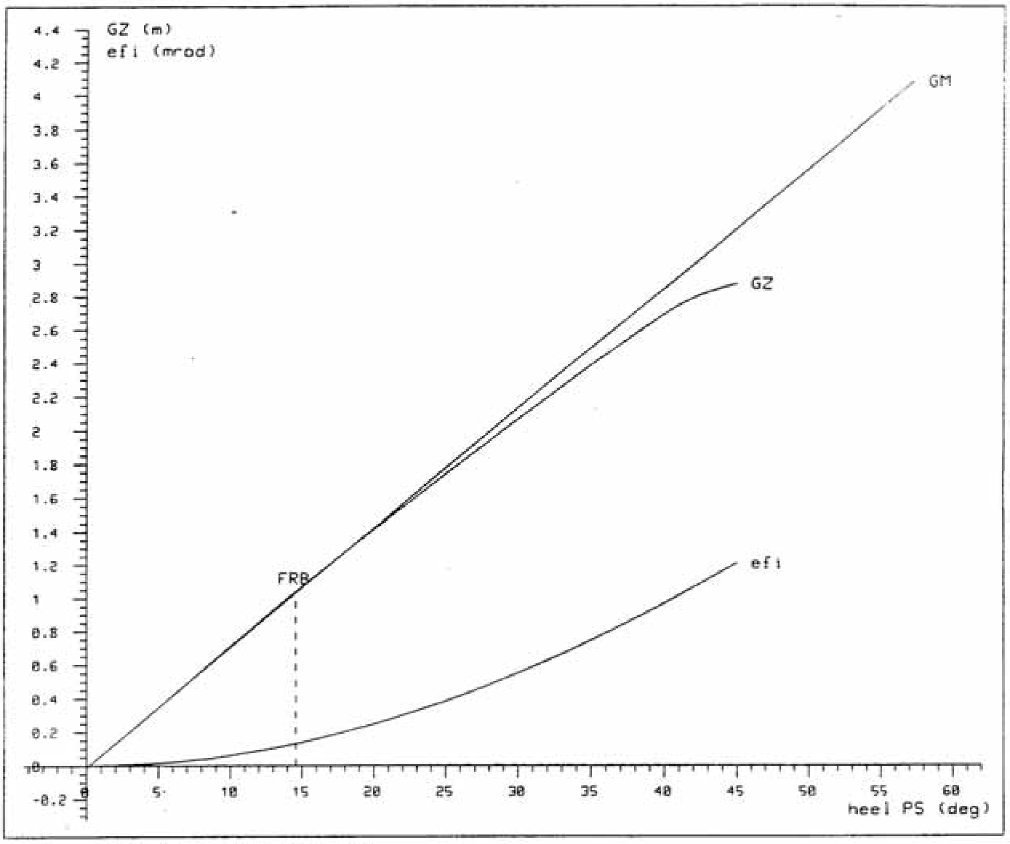
			X	FRAME
SHEAR FORCE (MIN)	-533.8 TON (12.4%)	POSITION:	28.2 M	47
SHEAR FORCE (MAX)	614.4 TON (14.3%)		111.6 M	153
SAGGING MOMENT	-8066.8 TONM (20.7%)		83.7 M	118
HOGGING MOMENT	2546.1 TONM (6.1%)		20.7 M	35

Appendix 5 Load condition, stability

FINNYARDS RAUMA

LOADING CONDITIONS PAGE 63

Loading condition ORE, GM-4.099 m



Scale : GZ-1/26.2, ANGLE-1/308.1

Loading condition: DEPARTURE, LOADING CASE IN ORE CONDITION

RCR	TEXT	REQ	ATTV UNIT	STAT	MINGM
AREA30	Area under GZ curve up to 30 deg.	0.055	0.550 mrad	OK	0.395
AREA40	Area under GZ curve up to 40 deg.	0.090	0.967 mrad	OK	0.349
AREA3040	Area of GZ curve btwn 30 and 40 d	0.030	0.416 mrad	OK	0.236
GZ0.2	Max GZ > 0.2	0.200	2.878 m	OK	0.214
MAXGZ25	Max. GZ at an angle > 25 deg.	25.000	45.000 deg	OK	-0.115
GM0.15	GM > 0.15 m	0.150	4.099 m	OK	0.150

Appendix 6 Damage stability, flooding conditions

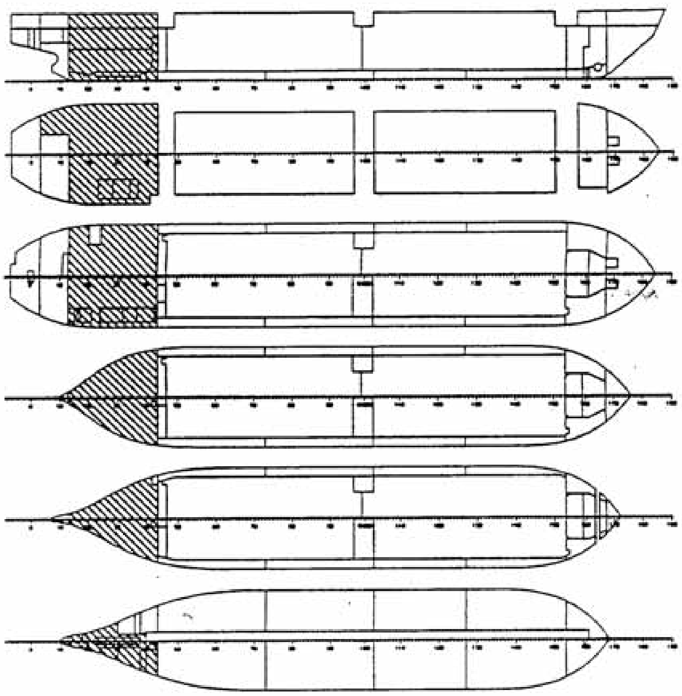
FINNYARDS
RAUMA
L409/A

DATE 95-12-20
SIGN TA

Damage definition check

Damage case IMOS3
Initial condition FULL

damaged compartment



Appendix 7 Damage stability, floating position and stability

INTACT CONDITION
Load case FULL

Mean draught: 8.19 m | No trim | Intact GMO: 0.85 m

FLOODED CONDITION
Damage case IMOS3, Comp. 3

Damaged compartments	Permeability
S4	0.85
S5	0.85
S6	0.95
SLUDGE TANK	0.95
LUB. OIL	0.95
GEAR OIL	0.95
LO STORAGE	0.95
SETTLING TANK	0.95
SETTLING TANK	0.95
▯AY TANK	0.95
TECH. WATER	0.95
POTABLE WATER	0.95
T22	0.95
CIRCULATING TANK	0.95
POTABLE WATER	0.95
FO OVERFLOW TANK	0.95
SI2	0.95
V1	0.95
CLEAN FUEL LEAK	0.95
WASTE OIL	0.95

Extent of damage:
Frame: 3 - 44
Penetration: inboard 4.32 m
Flooded volume: 2439.4 m3

Floating position

T aft	T midship	T forward	Trim	Heel	GM
11.04 m	8.99 m	6.94 m	-4.10 m	3.2 deg	0.68 m

Maximum righting arm (max. GZ): 0.14 m
Heel angle at maximum righting arm: 31.4 degrees
▯ange of the GZ curve: 36.8 degrees

Critical openings

	Frame	Distance to the waterline	Reduction per degree of heel
FROM WORKSHOP TO COMPRES. ROOM	13	-0.03 m	0.08 m
AT FR13 FROM WORKSHOP	13	0.41 m	-0.06 m
DOOR TO CO2 ROOM	48	1.17 m	0.11 m
ESCAPE FROM HOLD 2	47	1.93 m	-0.08 m
AIR DRYING ROOM	100	2.50 m	0.10 m
AIR DRYING ROOM	100	2.50 m	0.10 m
AIR PIPE FROM BW-TANK T7S	70	2.55 m	0.18 m
AIR PIPE FROM BW-TANK T6S	91	3.08 m	0.18 m
DOOR TO CARGO HOLD 1	98	3.18 m	-0.07 m
DOOR TO CARGO HOLD 2	100	3.22 m	-0.07 m
VENT. TO COMPRESSOR ROOM	9	3.34 m	0.13 m
HATCH COVER IN HOLD 2	49	3.40 m	0.17 m
VENT. TO STEER. GEAR ROOM	-6	3.47 m	0.10 m
HATCH TO STEER. ROOM	-6	3.56 m	-0.03 m
AIR PIPE FROM BW-TANK T7P	70	3.59 m	-0.15 m

Appendix 8 A calculation of the quantity of water in the engine room

M/S TALI

30.01.2008 grounded in J.fjord

Corrected drafts	
Fd	6,904
Md sb	8,520
Md bb	8,650
Ad	10,580
Hogging	15,7 cm
Displ. at 1.025	19811,48
1st. corr.	178,27
2 nd. corr.	123,08
Corr. displ.	20112,83
Dens. corr	-107,92
Disp. at 1,0195	20004,91
Light ship	5338
DWT	14666,91
Total weights	12861,0

Water 1806 tn

in engine room.

Water density	1,0195
M/M/M	8,624
trim	3,676
LcF	-2,30
TPC	27,2
△ mct	23,5

Weights	
Const / stores	12589
FW	53
Tech. W	19
Sludge	14
Bilge	5
HFO	111
DO	27
LO	16
Ballast	27
Total weights	12861

Ballast soundings

Tank.	*Sound cm.*	*Vol.*	*Corr.*	*Corrected vol.*
T 1	95	1,60	0,00	1,60
T 2 P	14	2,12	0,50	2,62
T 2 S	10	2,4	0,75	3,15
T 3 P	1	3,98	-3,37	0,61
T 3 S	0	2,5	-2,30	0,2
T 4 P	0	2,8	-2,55	0,25
T 4 S	0	3,5	-3,20	0,3
T 6 P	0	3,3	-2,60	0,7
T 6 S	0	4,1	-3,25	0,85
T 7 P	5	9,4	-8,45	0,95
T 7 S	3	8,68	-7,78	0,9
T 10	45	3	0,15	3,15
S 13	352	11,92	0,05	11,97

TRIM 1,5 m

Volume	27,25
Water dens.	1,0020
weight	27