Accident Investigation Board Norway

Issued September 2014

REPORT

MARINE 2014/09

REPORT ON MARINE ACCIDENT FINNØYGLIMT – LNIM FOUNDERED AT SLETTA NORTH OF HAUGESUND 7 OCTOBER 2011

AIBN has compiled this report for the sole purpose of improving safety at sea. The object of a safety investigation is to clarify the sequence of events and root cause factors, study matters of significance for the prevention of maritime accidents and improvement of safety at sea, and to publish a report with eventually safety recommendations. The Board shall not apportion any blame or liability. Use of this report for any other purpose than for improvements of the safety at sea shall be avoided.

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This report has been translated into English and published by the Accident Investigation Board Norway (AIBN) to facilitate access by international readers. As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.

Photo of ferry on the Norwegian west coast: Bente Amandussen

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NOTIFICATION OF THE ACCIDENT

At 01:15 on Saturday 8 October 2011, the Accident Investigation Board Norway (AIBN) was notified by the Joint Rescue Coordination Centre at Sola (JRCC-S) that the bulk carrier *Finnøyglimt* – LNIM had foundered at Sletta, an open stretch of sea north of Haugesund. Of the crew of three, all from Poland, two were picked up from the sea and one was registered as missing. A search operation was in progress to find the missing person. On the same day, the AIBN decided to initiate a safety investigation into the accident.

Figure 1: Finnøyglimt foundered at Sletta, north of Haugesund, at 23:40 local time on 7 October 2011. Source: AIBN

SUMMARY

At 15:55 on Friday 7 October, the bulk carrier *Finnøyglimt* departed from Helle in the Høgsfjord carrying 270 tonnes of aggregate in the forward part of the cargo hold and 430 tonnes of sand in the aft part of the cargo hold. The cargo was destined for Fitjar. The crew of three comprised the captain, an able seaman and an engineer. They expected to arrive at the unloading place in Fitjar at around three or four the next morning, depending on the weather.

Around 22:40, *Finnøyglimt* sailed past Gardsøya island at the northern end of the Karmsundet sound and entered open waters at Sletta, where the waves rose higher in a northwesterly wind. The able seaman and the engineer had retired to their cabins and the captain was alone on the bridge.

At 23:32, when *Finnøyglimt* was west of Ramnsholmene, the captain decided to turn the ship around and head back to Haugesund. Kvitsøy VTS registered the change of course and called up *Finnøyglimt* at the same time as *Finnøyglimt* was calling Kvitsøy VTS. The captain stated that there were problems with water ingression in the cargo hold and listing. The able seaman and engineer had turned out after being notified over the intercom system. *Finnøyglimt* continued to turn, but the

water ingression escalated and the vessel sank at 23:40. The able seaman and engineer made their way to the MOB boat and got a last glimpse of the captain though the aft wheelhouse windows. He was standing and holding a survival suit in his hands.

The AIBN's investigation concluded that water probably started to ingress when *Finnøyglimt* came into open waters at Sletta. The amount of green sea on deck was particularly high as a consequence of the ship's forward trim, and this caused water ingress in the cargo hold as the hatch covers were not watertight. When *Finnøyglimt* passed Tømmerflua at around 23:00, the sand cargo may have shifted and caused a list of 3.5°. The list and forward trim increased as the vessel took in more and more water. Finally, the vessel lost buoyancy and sank.

In the AIBN's opinion, *Finnøyglimt* was designed with the cargo hold too far forward. In homogenous load condition, the vessel would therefore be trimmed forward.

The investigation also uncovered that it was not established practice to secure the cargo hatch covers before departure. In the AIBN's opinion, the vessel's minimal crew may also have affected the preparations made prior to the voyage and resulted in the hatch covers not being secured.

After the accident, the AIBN commissioned SINTEF to analyse the properties of the sand and the aggregate. One important conclusion in the SINTEF report was that the addition of moisture would 'liquefy' the sand, i.e. a layer would form in which friction between the sand particles was reduced. This means that, if the moisture content of the sand were to reach 11.5% and the vessel was rolling, the sand could shift even though it had been levelled out. The shipper had not looked into this matter and had thus not the basis for informing the vessel's crew about the risk of such a cargo shift, as required by regulations.

The AIBN proposes three safety recommendations in this report. The first safety recommendation is addressed to the shipper to look into the properties of the products being shipped from its facilities and otherwise comply with the provisions of the Norwegian Regulations concerning the carriage of cargoes on ships and barges (the Cargo Carriage Regulations) as amended from time to time as regards providing information to ships about the properties of the cargo. The second safety recommendation is addressed to the Norwegian Maritime Authority (NMA) to take measures to determine the scope of the problem of shippers not informing ships about the properties of the cargo, and that it implement relevant measures to ensure that the provisions of the currently applicable Cargo Carriage Regulations are complied with. Thirdly, the Norwegian Maritime Authority is recommended to review its administrative practice relating to minimum safe manning by clarifying the term 'daytime arrangement'. In this investigation, reference is also made to Recommendation MARINE No 2012/04T, in which the AIBN recommended that the NMA order cargo ships for which stability calculations have not been carried out using an approved program, to procure new and complete trim and stability documentation; to Recommendation MARINE No 2012/05T, in which the AIBN recommended that the NMA introduce provisions on maximum forward trim/ minimum bow height; to Recommendation MARINE No 2012/07T, in which the AIBN recommended that the NMA take measures to increase awareness in the industry of risks associated with inadequate securing of hatches, and Recommendation MARINE No 2010/24T, in which the AIBN recommended that the NMA specify the scope of safety management systems for cargo ships with a gross tonnage of less than 500.

FACTUAL INFORMATION

1.1 Details of the vessel and the accident

Details of the vessel

Name of vessel	:	Finnøyglimt
Call signal/IMO No	:	LNIM/5341849
Owner	:	Finnøyglimt AS, NO-4160 Finnøy
Operator	:	Ryfylke Shipping AS, NO-4160 Finnøy
Home port	:	Stavanger
Register/Classification society	:	NOR/unclassed
Type	:	Cargo vessel (general dry cargo)
Year/place built	:	1961/Alfred Hagelstein Maschinenfabrik – Schiffswerft, Travemünde, Germany
Construction material	:	Steel
Length overall	:	47.96 m
Gross tonnage	:	437
Engine power	:	300 BHK (Deutz SBA8M528)

Figure 2: Finnøyglimt in the Sandeidsfjord on 23 August 2011. Photo: Tor Erlend Gjærde

Shipper and type of cargo

Shipper	:	NCC Roads AS, Helle branch, NO-4110 Forsand
Cargo in aft part of cargo hold	:	430 tonnes of sand (0–8 mm)
Cargo in forward part of cargo hold	:	270 tonnes of aggregate (8–16 mm)

Details of the accident

Time and date	:	At 23:40 on 7 October 2011
Accident location	:	Sletta near Haugesund, pos. N 59° 30.678´, E 005° 12.669´
Persons on board (POB)	:	3
Number of fatalities	:	1 (the captain)
Damage to the vessel	:	Sunk (lost)

1.2 Sources of factual information

Factual information has been obtained through interviews with representatives of the shipping company and the surviving crew. The AIBN has also obtained documentation from the shipper, the NMA and the Norwegian Coastal Administration (NCA). The vessel that sank has also been examined by means of a remote operated vehicle (ROV). Based on the documentation received, the AIBN has calculated the vessel's intact stability. In addition, the AIBN has obtained external assistance to analyse the properties of the cargo.

1.3 Chain of events

On Friday 7 October 2011, *Finnøyglimt* carried a cargo from Tau in Ryfylke to Talgje, east of the island of Rennesøy. The vessel arrived at Talgje at 01:50 and moored there for the night. It started unloading in Talgje at 07:00 and completed unloading at 12:30. The vessel departed from Talgje at 12:45.

At 14:30, *Finnøyglimt* arrived at Helle in the Høgsfjord, to take aboard a cargo of sand and aggregate destined for Fitjar. On arrival, the hatch covers were opened and loading commenced. The loading continued for approximately one hour. The vessel took aboard 430 tonnes of sand (0–8 mm) in the aft part of the cargo hold and 270 tonnes of aggregate (0–16 mm) in the forward part of the cargo hold. The cargo was levelled across the width of the ship using the vessel's excavator. In the longitudinal direction, the forward part of the cargo hold was not fully loaded. The cargo document that accompanied the cargo in question did not contain any information about the moisture content of the cargo, the transportable moisture limit (TML) or other information about the properties of the cargo or possible hazards.

When loading was completed, preparations were made for the voyage to Fitjar. The hatch covers were put into place and the excavator was parked at the aft end and secured with straps on the aft side. The arm was extended forward so that the bucket rested on the hatch covers. The hatch covers were not secured.

On departure from Helle, the vessel carried approximately three tonnes of fuel oil. This was distributed between the day tank and the starboard wing tank in the engine room. There was little water in the freshwater tank and the plan was therefore to bunker fresh water at Storasund on Karmøy.

After departing Helle at 15:55, the able seaman remained on deck for about half an hour in order to grease the excavator in preparation for the unloading operation scheduled to take place on the following day. Afterwards, he ate a meal and watched a film together with the engineer. He then went to the wheelhouse and asked the captain to wake him before arriving in Haugesund, so that he could assist with bunkering fresh water.

When the vessel arrived at Storasund, approximately five tonnes of water were loaded into the freshwater tank located just aft of the engine room. The tank was not filled to the top. *Finnøyglimt* left Storasund at 22:20.

After the departure from Storasund, the able seaman went to the wheelhouse and spent a few minutes talking with the captain. The captain said that they would arrive at the unloading place at Fitjar around three or four in the morning, depending on the weather. The able seaman then retired to bed.

While the able seaman went to the wheelhouse after the departure from Storasund, the engineer went down into the engine room to check the pressure in the ballast tanks. The engineer concluded that all the ballast tanks were empty. At the same time, he made a routine check of the main engine and then proceeded to the mess to secure his computer and other personal belongings from falling down as a result of expected rolling on crossing Sletta. He then retired to his cabin and went to bed.

At 22:37, *Finnøyglimt* was west of Gardsøya island at the northern end of the Karmsundet sound and was thus entering the more open waters at Sletta; see Figure 3. This area is considered dangerous as a result of the sea conditions. A moderate northwesterly gale was blowing on the night in question, and in the area west of Sletta there were heavy seas consisting of northwesterly wind waves with a significant wave height of 4.5 metres and 2-metre high westerly swells.

AIS data and calculations of the vessel's accelerations show that, as it proceeded on its voyage, *Finnøyglimt* was exposed to greater pitching, surging and rolling movements as a consequence of the wave conditions at Sletta; see Annex C.

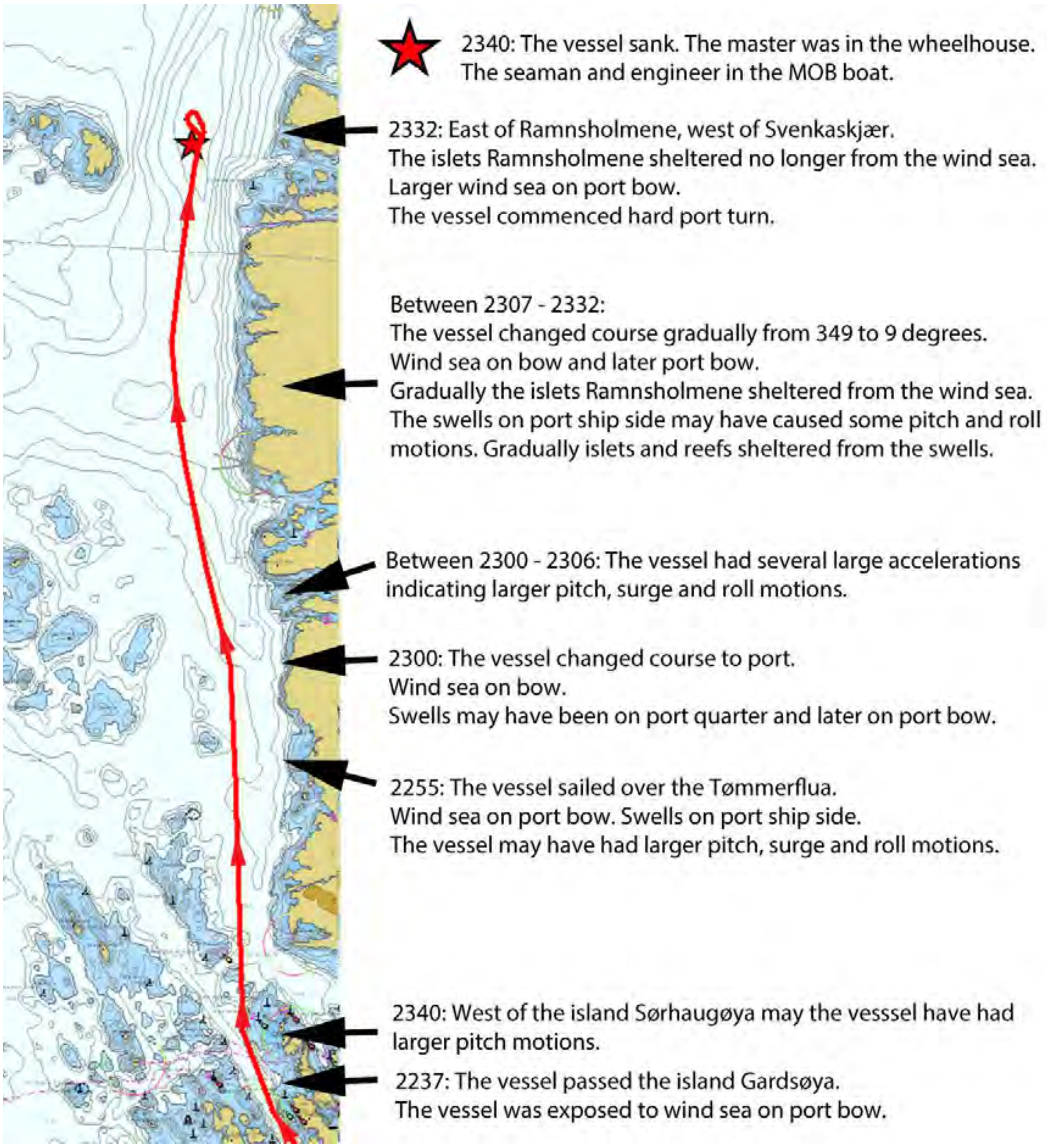

Figure 3: Map showing Finnøyglimt's voyage across Sletta. Based on charts/maps provided by: the Norwegian Mapping Authority, Geovekst and municipalities. Illustration: AIBN

After passing west of Gardsøya, the vessel was exposed to wind waves crashing against the port side of the bow. Just west of Sørhaugøya island, the vessel probably pitched as a result of passing from relatively shallow to much deeper waters.

On crossing Tømmerflua, the port side of the bow was exposed to both wind waves and swells. Because of the configuration of the sea floor, the waves may have shoaled in this area, thus increasing the vessel's pitching, surging and rolling movements.

Just north of Tømmerflua, *Finnøyglimt* changed course to port and headed north-northwest.

Several major accelerations during the next six minutes suggest that the vessel's pitching, surging and rolling movements had increased. These movements were probably caused by the bow being exposed to wind waves in combination with high swells. The swells had probably shoaled and changed direction on encountering shallows and skerries.[1] *Finnøyglimt* may therefore have been affected by swells on the port side abaft the beam and at the bow.

The able seaman noticed that the vessel was rolling 15 or 20 minutes after he had gone to bed, but was able to fall asleep. The engineer, on the other hand, was unable to sleep because of noise from loose equipment in the galley as a result of the rolling.

Between 23:07 and 23:32, *Finnøyglimt* sailed from Stølsholmen to west of Svenkaskjær. During this period, the vessel gradually changed course from 349 to 9 degrees. Wind waves hit the bow head on, and further to port as the vessel changed course. The port side was affected by swells. These swells may have caused some surging and rolling of the vessel. After 23:23, shallows, islets and skerries may have shielded the vessel against the westerly swells. When sailing northwards from Stølsholmen, the islets and skerries may have provided some shelter against the wind waves. As no major accelerations were observed during that period, pitching was probably moderate.

At 23:32:20, *Finnøyglimt* was sailing mid-channel between Svenkaskjær and Ramnsholmene (850 m west of Svenkaskjær and 1 000 m east of Ramnsholmene); see Figure 4. Its position was N 59 30.69’, E 5 12.76’. As before, this area probably sheltered from the westerly swells. Once the vessel was opposite Ramnsholmene, however, there was probably little shelter against the northwesterly wind waves. In other words, at that point in time, the port side of the vessel’s bow probably came up against higher wind waves than before. The vessel continued to be exposed to these sea conditions until it foundered.

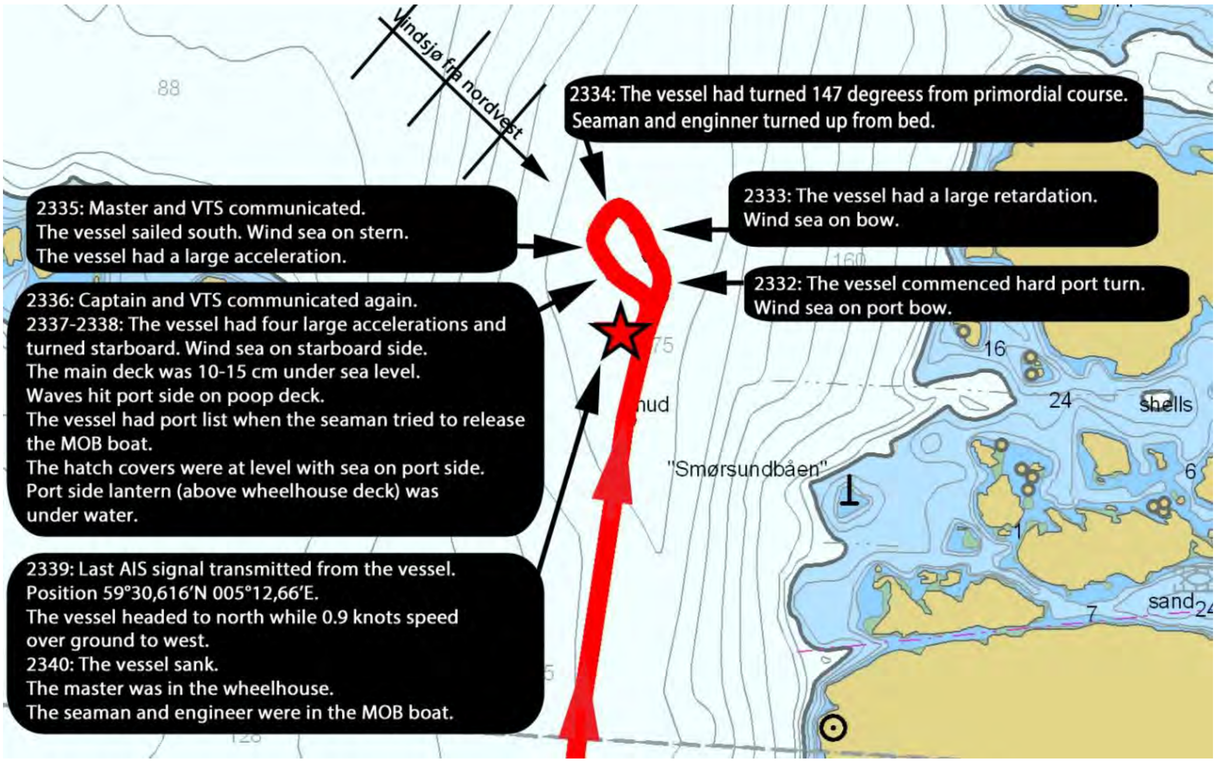

Figure 4: Map showing Finnøyglimt’s course between Svenkaskjær and Ramnsholmene. Based on charts/maps provided by: the Norwegian Mapping Authority, Geovekst and municipalities. Illustration: AIBN

[1] Refraction followed by diffraction

At 23:32:30, *Finnøyglimt* had a course of 4 degrees and started to turn hard to port while losing speed. It continued to turn until 23:36:06. In the course of these 3.5 minutes, the vessel turned 254 degrees to port. After that, it turned to starboard.

At 23:33:16, while the vessel was turning to port and the speed was dwindling, the vessel was subject to a major retardation. The vessel had a course of 336 degrees at the time, which meant that the wind waves were hitting the bow head on.

The able seaman, who had fallen asleep, was woken up as *Finnøyglimt* made three marked 'jumps' followed by vibrations as the vessel hit the trough of a wave. He opened his eyes but did not get out of bed. The able seaman's cabin was above the engine room and he heard the engine stalling as the propeller was raised above water when the vessel hit the troughs of the waves. According to the able seaman, the vessel hit the trough of the waves at intervals of 5–6 seconds. Just after the third impact, he heard a strange, metallic noise, which he described as sounding like a corkscrew being scratched against a metal plate.

The engineer, who had been unable to fall asleep, also felt the three marked impacts of the vessel hitting the troughs of the waves and heard the metallic noise.

Approximately 10 seconds after the third impact, the captain announced over the intercom that there was something wrong with the ship.

Kvitsøy VTS observed *Finnøyglimt's* change of course and called up the vessel at 23:34:23, at just about the same time as *Finnøyglimt* was calling Kvitsøy VTS.

At 23:34:40, *Finnøyglimt* had a course of 217 degrees (course over ground (COG): 269 degrees), i.e. a change of 147 degrees in relation to its original northerly course. At this point, *Finnøyglimt* continued to turn hard to port.

Between 23:34:41 and 23:35:29, Kvitsøy VTS and *Finnøyglimt* communicated as follows:

Kvitsøy VTS: *Are you changing course? Is everything OK with you?*

Finnøyglimt: *No, I have heavy list on the port side, heavy list. I get water into my compartment on the port side. I try to go back to Haugesund.*

Kvitsøy VTS: *Shall I get some assistance for you?*

Finnøyglimt: *Repeat the message.*

Kvitsøy VTS: *Shall I get some assistance for you?*

Finnøyglimt: *Yes, probably I need assistance.*

At 23:35:19, *Finnøyglimt* was subject to a peak acceleration of as much as 0.103 m/s^2. The vessel was still turning hard to port. Its course was 150 degrees, while the COG was 198. In other words, the bow of the vessel was pointing southeast, while the vessel was moving south. The speed had dropped to 4.1 knots. At that point in time, the wind waves were hitting *Finnøyglimt* abaft the beam. Since the waves hit abaft of the beam, they may have lifted the vessel's afterbody.

At 23:35:29, Kvitsøy VTS called *Solfjord*, a cargo vessel that was approximately half an hour behind *Finnøyglimt* on the same route north across Sletta. *Solfjord* was asked to go alongside *Finnøyglimt* to provide assistance, if possible.

At 23:35:46, *Finnøyglimt* had a course of 123 degrees and was still turning to port.

At 23:36:17, Kvitsøy VTS and *Finnøyglimt* communicated as follows:

Kvitsøy VTS: *Finnøyglimt, Kvitsøy VTS.*

Finnøyglimt: *Go ahead.*

Kvitsøy VTS: *How many people are on board?*

Finnøyglimt: *Three people on board, three people on board.*

Kvitsøy VTS: *Three people, and you are trying to go back to Haugesund?*

Finnøyglimt: *Yes, I try to go back, but I have heavy list, heavy list.*

Between 23:36:56 and 23:37:30, it can be seen from the AIS data that the vessel was subject to four major retardations. The time that lapsed between these retardations was 11, 12 and 11 seconds, respectively, which corresponds to the periods of the wind waves. During this period, the vessel changed course from 199 to 270 degrees. The ship was moving sideways and the speed dropped from 5.3 to 3 knots. In the course of these 34 seconds, the vessel was turned sideways to the wind, so that the wind waves hit the starboard side.

After 23:37:30, *Finnøyglimt* was not subject to any further accelerations, but it continued to turn to starboard.

Following the captain's announcement over the intercom, the able seaman quickly proceeded to the wheelhouse, wearing only his underwear. The captain had turned on the floodlight, directing it towards the deck to check the hatch covers. The able seaman observed that all hatch covers were in place, but that the vessel was shipping 10–15 cm of water on the port side of the deck. The captain told the able seaman that they would try to seek shelter, to go 'to inside'. The able seaman saw land to port and assumed that they were then approximately 500–700 m from the shore.

The able seaman returned to his cabin to get dressed, but was soon back in the wheelhouse. He noted that, by then, the water on the port side had risen to a much higher level. Around this time, the able seaman also overheard the captain communicating with Kvitsøy VTS. The able seaman expressed his understanding of the situation to the captain and they agreed that it was serious. The able seaman proposed that he should start readying the MOB boat for launching, to which the captain agreed. The able seaman asked the captain to press the distress button on the VHF radio, but the captain replied that Kvitsøy VTS was informed of the situation.

Following the announcement over the intercom, the engineer was also quick to leave his cabin, but he did not bring any outer garments. He opened the door on the port side of the deckhouse on the poop deck to get an impression of the conditions. In the light from the floodlight, he observed that all hatch covers were in place. While he was standing in the door jamb, he saw a big wave that looked as if it might leap into the corridor. He therefore closed the door quickly before the wave hit, after which he went up to the wheelhouse.

From 23:37:35 until 23:37:53, the vessel once again held a south-southeasterly course, though at only half the original speed.

The able seaman tried to release the lines that held the MOB boat in place, but found it difficult because of *Finnøyglimt's* listing. He therefore returned to the wheelhouse where he caught sight of the engineer. As the able seaman asked the engineer to help him launch the MOB boat, he observed that the hatch covers were at the same level as the sea on the port side. The two of them together eventually managed to release all the lines with which the MOB boat was fastened. As the waves leapt over the wheelhouse deck on the port side, the MOB boat floated out of its cradle.

They then returned to the wheelhouse, where the able seaman remained standing in the door jamb while telling the captain that the MOB boat was ready. The engineer retrieved a survival suit intending to put it on, but stopped when the able seaman claimed that they did not have the time to do so. While this was going on, *Finnøyglimt* was sinking very quickly, so that the port side lantern, which was mounted 45 cm above the wheelhouse deck on the wing, became completely submerged in water. As the engineer left the wheelhouse, he heard the captain say 'please repeat, please repeat' on the VHF radio.

The seaman then took down a round lifebuoy from the side of the wheelhouse and put it around his waist. He climbed onto the MOB boat davit and jumped into the MOB boat. He hit his head in the process and momentarily blacked out. The engineer, who had also put a lifebuoy around his waist, climbed up the smokestack and jumped into the MOB boat from there. He noticed that the MOB boat was still attached to something and called out to the seaman and told him about this. The able seaman regained consciousness and saw that two wires were still hooked onto the boat. He pulled at them and was able to release the hooks. He then found another line that had not been released. This was the line to the buoy light / smoke box from the lifebuoy around his waist. The line soon snapped, however. The line from the lifebuoy that the engineer had around his waist also broke when the able seaman pulled on it.

At 23:38, Kvitsøy VTS notified the JRCC-S, which, in turn, notified Rogaland Radio.

AIS data / radar information show that, at 23:38:53, *Finnøyglimt* was moving on a west-southwesterly course at approximately one third of its original speed.

At 23:39, Rogaland Radio repeatedly tried to call up *Finnøyglimt* on channel 16, but there was no answer.

At 23:39:29, Kvitsøy VTS called up *Finnøyglimt*, without getting an answer.

At 23:39:14, when the last AIS signal from the vessel was recorded, it had a course of 355 degrees and a COG of 258 degrees. The vessel was moving at a speed of 0.9 knots. This means that the vessel had a northerly course, but was moving westwards at very low speed. The vessel's position was then 59°30.616'N, 005°12.66'E.

After the engineer and able seaman had boarded the MOB boat, *Finnøyglimt* quickly sank further into the sea. They got a last glimpse of the captain through the aft wheelhouse windows. He was standing inside the wheelhouse with a survival suit in his hands.

A few seconds after the captain was observed in the wheelhouse, only the smokestack and exhaust flow were visible until *Finnøyglimt* disappeared from the surface. The able seaman and the engineer have estimated that the vessel had a list of 30 degrees when it sank.

A weak radar echo was recorded at 23:39:59. This was the last radar echo recorded by Kvitsøy VTS.

The able seaman reckoned that it took two to three minutes from the time he was woken up in his cabin until *Finnøyglimt* disappeared. He believed that the vessel disappeared less than one minute after he had observed that the hatch covers were submerged in water on the port side.

The engineer and able seaman used paddles to prevent the MOB boat from drifting towards the breakers. They caught sight of an approaching vessel that was using its floodlight to search the sea, and they therefore activated the MOB boat's flashing lights.

At 23:41:17, *Solfjord* communicated to Kvitsøy VTS that it observed a flashing light east of Ramnsholmene.

1.4 The rescue operation

At 23:42, Rogaland Radio notified the JRCC-S that it had lost contact with *Finnøyglimt*. The JRCC-S asked Rogaland Radio to issue a Mayday Relay.

At the same time, the cargo vessel *Holmefjord* passed Ryvarden lighthouse on a southerly course. The vessel informed Kvitsøy VTS that the crew had observed *Finnøyglimt* on the radar a short while back, but that the echo signal had disappeared.

At 23:43, Rogaland Radio sent a DSC distress alert and Mayday Relay message to all ships, with the information that *Finnøyglimt* was listing. The most recently recorded position of the vessel was stated and boats in the area were requested to proceed to that position to provide assistance.

At 23:44, the JRCC-S registered that *Finnøyglimt's* emergency beacon had been released. The emergency beacon had been released at 23:40.

At 23:46, *Solfjord* informed Rogaland Radio that it was 0.5–1 nautical mile from the position and could see *Finnøyglimt* on the AIS. They searched, but were unable to locate the vessel.

At 23:55, the crew on *Solfjord* informed Rogaland Radio that they saw two people in a MOB boat.

The engineer and the able seaman were on the lookout for the captain, thinking that he may have jumped into the sea just before *Finnøyglimt* went down. But visibility was poor, as big waves were crashing into the boat and it was raining and very cold.

At 00:03 on 8 October, *Solfjord* informed Rogaland Radio that it had taken aboard two people from the MOB boat.

At 00:05, the SAR vessel *Bergen Kreds* had arrived near to the position of *Solfjord*.

In the course of the next ten minutes, *Bergen Kreds* reported that it had located two empty rescue rafts and a lifebuoy with lights. It had also observed an object that appeared to be a flashing emergency beacon.

At 00:22, a Sea King rescue helicopter arrived in the area and started to search for the missing captain. The product tanker *Dart* had arrived in the area from the north and joined *Solfjord*, *Holmefjord* and *Bergen Kreds* in the search southeast of Ramnsholmene.

At 00:46:24, the incomplete AIS-signal from *Finnøyglimt* could still be observed.

At 01:44, the Coast Guard vessel *Bergen* arrived in the area and took over command of the search from *Bergen Kreds*. The search area was gradually extended as morning approached.

At 03:48, the SAR helicopter abandoned the search and returned to base.

At 04:29, *Solfjord* set the two surviving crew ashore in Haugesund. Under the circumstances, they were in relatively good shape, and they were therefore brought to a hotel.

In the early hours of the morning and through the day, the shore zone, islands, islets and skerries were searched from the air as well as from the shore, where police dogs were also used in the effort. The Norwegian Coastal Administration’s patrol aircraft was also employed in the search. The missing captain was not found and, at 18:00, the JRCC-S decided to abandon the search.

1.5 Search for missing, presumed dead

When the search and rescue operation was abandoned, it was the responsibility of Haugaland og Sunnhordland police district to search for the person who was missing and presumed dead.

The police decided to conduct the search using a subsea ROV. The AIBN felt that it was necessary to observe the wreck and the surrounding seabed as part of its safety investigation. It was therefore agreed that the police and the AIBN would collaborate on hiring in the vessel *Seabed Worker* with a ROV that was able to operate at great ocean depths.

Finnøyglimt was located one week after it sank, in position N 59° 30.678’, E 005° 12.669’, at a depth of 371 metres. Before the wreck was located, the ROV’s video cameras had been used to search relatively wide areas of the seabed south and east of the position in which it was found. After searching the area around the wreck and the inside the wheelhouse, the search was abandoned without the missing person having been found.

1.6 Observations of the wreck and the surrounding seabed

When the search for *Finnøyglimt's* captain was abandoned, the ROV from *Seabed Worker* was used to examine the wreck and the surrounding seabed.

1.6.1 Observations of the wreck

Finnøyglimt stood on its keel, but was listing to port. The wreck, which was deeply embedded in loose seabed sediments, lay in an east–west position, with the foreship towards the west ('course' 271º).

Figure 5: The photo shows the bow area on Finnøyglimt's port side. Source: Seabed Worker's ROV

1.6.1.1 *The hull*

The lower part of the hull was depressed along the whole length of the starboard side. Because the wreck was deeply embedded and listed to port, the lower part of the hull was not visible on the port side.

The forward shoulder was depressed on both sides, and buckling was observed in the foreship on the starboard side.

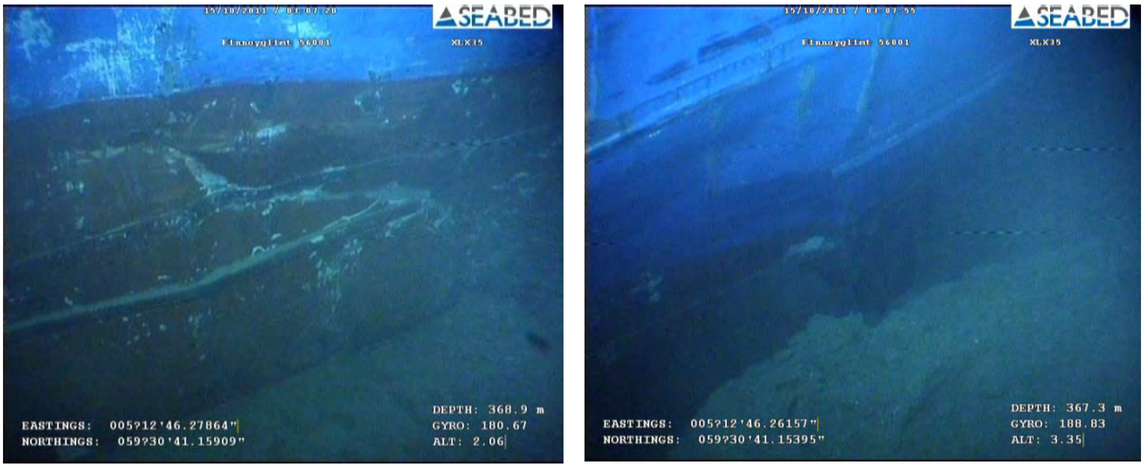

Figure 6: The photos show damage to the hull on Finnøyglimt's starboard side. Source: Seabed Worker's ROV

1.6.1.2 *Hatches*

Hatch covers nos 1, 4, 5, 6 and 7 (numbered from fore to aft) lay on top of the coaming, but hatch covers nos 2 and 3 were missing. Hatch cover no 1 was clenched inwards on the port side, no 6 bent upwards at the aft end and no 7 bent upwards at the forward end. Hatch cover no 7 had been partially pushed under hatch cover no 6.

Figure 7: The photo on the left shows hatch cover no 6 bent upwards at the aft end and hatch cover no 7 bent upwards at the forward end. The photo on the right shows a cargo hatch cover that lay on Finnøyglimt's starboard side, fastened with a wire. Source: Seabed Worker's ROV

In the areas where the hatch covers were missing (nos 2 and 3), the jacks and securing devices were clearly visible. The aftmost securing device for hatch cover no 3 was missing on the starboard side. The jacks were down and the other securing devices lay unengaged in the steel frame to which they were attached.

In the areas where the covers were not missing, the jacks and securing devices were less visible. Observations of the hatch covers' sides showed, however, that none of the securing devices had been pulled up to the fastening lugs on the hatch covers and engaged.

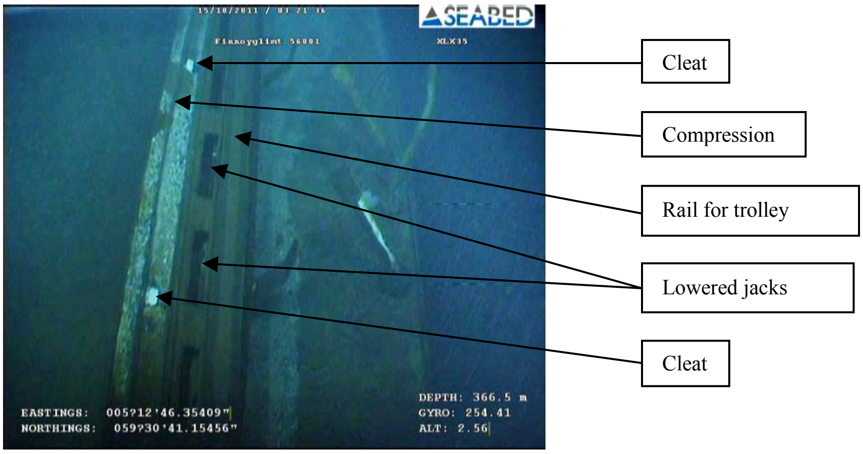

Figure 8: Hatch coaming and wheel track for excavator trolley seen from above. Source: Seabed Worker's ROV

The cover for the access hatch at the forward end of the forecastle deck was in place on the coaming, but was not secured. The cover for the access hatch at the aft end of the forecastle deck on the port side was open. It was hinged at the forward end.

1.6.1.3 *Transverse bulkhead in cargo hold*

The transverse bulkhead in the cargo hold appeared to be intact.

1.6.1.4 *Bulwark and railings*

Parts of the starboard bulwark aft of the forecastle bulkhead had been torn off and bent forward, and parts of the starboard bulwark forward of the beam had been torn off and bent backward. The aft railings on boat deck were bent forward, and a part of the extended deck and railings on the starboard side of the boat deck was bent upwards and forwards. The railings on the roof of the wheelhouse were deformed.

1.6.1.5 *Windows and doors*

The wheelhouse window furthest to starboard was broken. The door leaf of the starboard wheelhouse door was missing, and the door leaf for the port wheelhouse door was broken. The door to the forward companionway had been pushed through the door jamb.

1.6.1.6 *The masts*

The foremast on the forecastle deck was bent (broken) forward towards starboard. The radar mast that had been mounted aft on the starboard side of the wheelhouse roof had come off and fallen down onto hatch cover no 7 just aft of the excavator trolley. The lantern mast, which also stood on the wheelhouse roof, was bent forwards (broken) on the wheelhouse roof.

Figure 9: The photo on the left shows the broken foremast, pointing forwards to starboard. The photo on the rights shows the radar mast on the wheelhouse roof, lying forward over the aftmost hatch cover. Source: Seabed Worker's ROV

1.6.1.7 *The rudder*

The rudder appeared to be in a starboard over position.

1.6.1.8 *The cargo*

The sand in the aftmost part of the cargo hold has shifted to port. Towards the transverse bulkhead at the fore end of the hold, however, the sand was more evenly distributed across the width of the vessel. Forward of the transverse bulkhead, the aggregate had been thrown forwards towards the port side.

On the starboard side, the level of the cargo was some way under the deck. On the port side, the cargo was on level with the top of the hatch coaming. Some aggregate had been thrown over the coaming and had settled on top of the seabed sediments on deck.

Figure 10: The photo shows how the cargo has been 'thrown' (shifted) towards the port side. Source: Seabed Worker's ROV

1.6.1.9 *The excavator*

As described in section 1.3 on the chain of events, on this particular voyage, the excavator was parked at the aft end and secured with straps on the aft side. The arm pointed forward and the bucket rested on the hatch covers. The ROV video recording showed that the excavator was still located aft on deck with its arm extending forward. However, the excavator had tipped forward so that the arm extended into the cargo hold with the bucket resting on top of the cargo.

Figure 11: The photo shows the excavator bucket and arm dug into the aggregate in the cargo hold. The photo also shows how the cargo in the hold has been thrown towards the port side. Source: Seabed Worker's ROV

1.6.2 <u>Observations of the seabed around the wreck</u>

There were no visible marks in the seabed sediments forward of the bow. On the port side of the bow, the seabed sediments had been 'ploughed up', while there were some smaller plough marks on the starboard side of the bow. There were no visible marks aft of the stern. Some seabed sediment had been thrown up on deck on the forward port side. Sediment was seen to have settled almost evenly along the whole coaming on the port side.

One cargo hatch cover was found on the seabed 36 metres to the south of and 85 metres behind the bow of *Finnøyglimt*. Another cargo hatch cover was found on the seabed on the starboard side of the wreck. The hatch cover found on the starboard side of the wreck was attached to a wire and had been 'delaminated'.

A cover belonging to one of the rescue raft containers was found 26 metres south of and 86 metres behind the bow of *Finnøyglimt*.

1.7 The fairway, weather and sea conditions at the time of the accident

1.7.1 <u>General description of the waters</u>

On the NMA's navigation charts, Sletta is marked with a warning to show that this is a precautionary area. Reference is also made to the publication *Den norske los* ('The Norwegian Pilot') for more information.

In *Den norske los* Volume 1,[2] the following is stated about Sletta:

> *'Sletta is an open area of sea NW of Haugesund. The depths vary widely, from shallows a couple of metres deep down to approximately 250 m. The area is relatively narrow, and the wide depth variations cause the sea to become very rough and choppy when the wave direction is between SW to NW. The conditions deteriorate even more when the tidal current moves in the opposite direction to the waves.'*

The Norwegian Meteorological Institute has assessed the fairway as follows:

> *'Sletta is somewhat sheltered from northwesterly waves, particularly as far north as at the point where it is assumed that the vessel foundered. There is somewhat less shelter further south at Sletta. In the middle of Sletta, westerly swells meet with relatively little hindrance, but there are some islets and shallows that should dampen the swells when one gets as far north as to 59° 30.5' N. Special seabed conditions may nonetheless change the direction of the swells.'*

1.7.2 Weather forecast for the period in question

At 15:00 on Friday 7 October 2011, the Norwegian Meteorological Institute issued the following weather forecast for the coastal area Karmøy – Fedje. The forecast covered the period until 24:00 on Saturday:

> *'Karmøy – Fedje:*
>
> *Northwesterly fresh gale 20, deceasing to moderate gale 15 during the night. Showers. Early Saturday morning, northwesterly fresh breeze 10. Some showers. Saturday morning till midday, northerly fresh breeze 10. The weather will gradually become dry. In the evening, varying breeze. Mostly fair weather.'*

The Norwegian Meteorological Institute also issued special forecasts concerning the wave conditions at Sletta, as shown in Figure 12. The special forecasts were available on the internet. The figure shows that a significant wave height[3] of less than 2 metres and a maximum single wave height of less than 3.5 metres was forecast in the area between Bleivik and Ryvarden.

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[2] Area 17, Chapter IX, the NMA's hydrographic division, 7th edition, 2004.
[3] Significant wave height: the mean wave height of the highest third of the individual waves over a 20-minute period. Single waves can be 1.5 to 2 times as high as the significant wave height.
Source: http://metlex.met.no/wiki/Signifikant_bølgehøyde

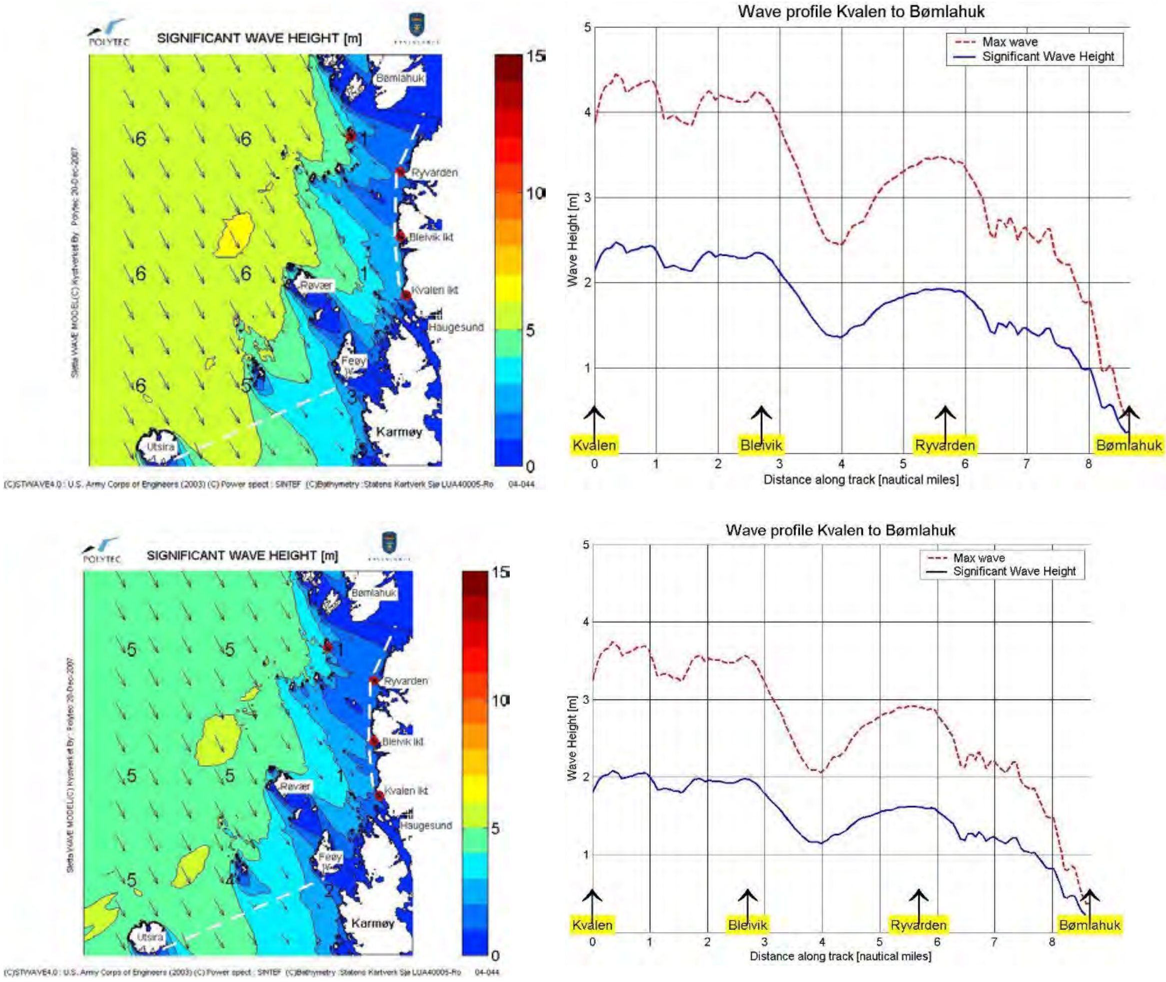

Figure 12: Map and graphs showing forecast wave heights for the area in question at 22:00 and 24:00, respectively, on the day of the accident. Source: Norwegian Meteorological Institute; see http://spesial.met.no/refraction/sletta/sletta_ged.shtml.

1.7.3 Observations during the period in question

According to information provided by the cargo ship *Solfjord*, there were 3–5 m high waves in the area when *Finnøyglimt* foundered. Measurements showed a northwesterly wind of 20 m/s.

Observations from Røvær weather station during the relevant period show a mean wind speed of 16 m/s, with gusts of up to 22 m/s. A mean wind speed of 19 m/s and strongest gust of 24 m/s had been recorded earlier that evening.

Model calculations carried out by the Norwegian Meteorological Institute after the accident show that the significant wave height in the area off Sletta was around 4.5 metres during the period in question. This is regarded as heavy seas. The heavy seas consisted mostly of wind waves from northwest. There were also westerly swells with a wave height of around two metres.

The model calculations are representative of wave conditions in open sea areas that are not protected by land masses or in which there are great depth variations. The model has thus not taken into account any local variations in wave conditions in near-coastal waters.

The Norwegian Meteorological Institute lack reliable data on current conditions in the area.

1.7.4 Brief description of wave characteristics and how waves may be affected by seabed topography and current

1.7.4.1 *Simplified wave equations*

Based on simplified theory, the following relationship is assumed to exist between wave period T and wave length λ in deep water:

$$\lambda = \frac{gT^2}{2\pi}$$

, where g is the acceleration due to gravity, 9.81 m/s^2.

The model calculations show that northwesterly wind waves made the greatest contribution to the waves. An additional contribution was made by swells, i.e. waves that had been generated elsewhere some time ago.

These calculations assume that the sea is open and do not take account of local conditions near the coast. It is therefore necessary to consider how the near-coastal conditions affected the propagation of wind waves, how the seabed conditions (topography) may have affected the wind waves in the areas the vessel passed through, how the seabed topography may have affected the swells in the areas the vessel passed through, and how the current conditions may have affected the waves. Since there is more uncertainty attached to the actual current conditions, weight will not be given to these conditions in the analysis.

1.7.4.2 *Interaction between waves and seabed topography*

The seabed and onshore topography can affect the waves. How the waves change will depend on a number of conditions. Without describing this in full, the AIBN would like to draw attention to some of the conditions that may have been relevant to this particular accident.[4]

Shoaling occurs as the waves move from deep water to a finite water depth. This means that the waves change shape in that they become shorter (decrease in length) and higher. In this context, ‘deep water’ is defined as water of a depth that is greater than half the wavelength. A ‘finite water depth’ is here defined as a depth equal to or less than half the wavelength.

Slowly varying depths may cause wave refraction (also called depth refraction or bottom refraction) and diffraction. By slowly changing seabed levels is meant that the change in depth is small compared with the wavelength. As the water depth changes, the height, length and direction of the waves may change.

Sudden changes in the seabed level, for example a steeply sloping seabed, may cause both wave reflection and wave transmission.

[4] Compendium Oceanography TMR4230. Dag Myrhaug, January 2006, Department of Marine Technology, Norwegian University of Science and Technology (NTNU).

Where the seabed topography interacts with the waves, the wave period will remain constant.

1.7.4.3 *Changes to the wave conditions caused by current*

The waves may also interact with the current. When the waves and the current move in the same direction, the wavelength increases while the wave height decreases. When the current moves in the opposite direction to the waves, the wavelength decreases while the wave height increases. This can create waves that are dangerous for small vessels. The wave direction can also change as a result of the interaction between the waves and the current.

1.7.5 <u>Rough calculation of wave characteristics</u>

1.7.5.1 *Wind waves over deep water:*

Since the wind was northwesterly, it is concluded that the wind waves at Sletta were not affected by the onshore topography.

Given a significant wave height of 4.5 metres, individual waves may have been as high as 6.75–9 metres in deep water and where they were not affected by the onshore topography.

Given a dominant wave period of 12 seconds, it is assumed that the dominant wavelength in deep water was around 225 metres.

The dominant wave direction was northwesterly, i.e. 330 degrees.

The seabed conditions will start to affect these waves at a depth of about 112 metres or less.

As shown in the special wave forecast from the Norwegian Meteorological Institute, the waves are affected by seabed and onshore topography. The special forecast shows that the waters through which *Finnøyglimt* passed were partly sheltered from wind waves from the north-west.

1.7.5.2 *Swells over deep water:*

The swells were approximately two metres high.

It is assumed that swells with wave periods of 14–15 seconds had wavelengths of 306–351 metres.

The dominant wave direction was westerly, i.e. 270 degrees.

The seabed conditions will start to affect these waves at a depth of about 150–175 metres or less.

1.8 Shipping company and fleet

Finnøyglimt was owned and operated by Ryfylke Shipping AS on Finnøy. The company was formed in 2005. At the time of the accident, the shipping company owned two other cargo vessels in addition to *Finnøyglimt*: *Finnøyfjord* (LESA) and *Finnøybulk* (JWRS).

The shipping company had recently sold a fourth vessel, the cargo vessel *Basen* (LMPC). All these vessels were mainly used for the carriage of sand.

In addition to having capital invested in the company, the owner was also involved in the operation of the vessels. He was the company's general manager/operations manager, and was also responsible for everything that had to do with the vessels' cargoes and cargo carriage contracts.

The shipping company had not established a documentable safety management system for *Finnøyglimt* and *Finnøyfjord*, both of which had a gross tonnage of less than 500.

After the *Finnøyglimt* accident, the owner has sold the two remaining vessels and dissolved the shipping company.

1.8.1 The vessel's crew

At the time of the accident, *Finnøyglimt* had a crew of three: - the captain, an engineer and an able seaman. They were all Polish nationals.

The captain, who was born in 1954, held a master's certificate in accordance with STCW-78/95 Reg. II/2, issued in Poland, and a CRA[5] issued by the Norwegian Labour and Welfare Organisation's maritime office in Stavanger. He was hired by the shipping company in 2006 and was captain of the cargo vessel *Basen* until it was sold. He had acted as a 'stand-in' captain of *Finnøyglimt* for approximately two months prior to the accident.

The engineer had been with the shipping company since 2007. He had worked on board *Finnøybulk* for most of this period. He started working on *Finnøyglimt* two weeks before the accident.

The able seaman had approximately nine years' experience on board this type of vessel. At the time of the accident, he had worked on *Finnøyglimt* for just over three years.

1.8.2 Work practice on *Finnøyglimt*

As no formal management system had been established for *Finnøyglimt*, it was largely up to the shipboard crew to establish procedures for safe operation. As regards procedures for securing the cargo hatch covers, the able seaman informed us that these were secured on the captain's orders and always during winter. According to the owner, the onshore office had sent the vessel a written procedure on the securing of hatches to be posted on board, which stated that the hatches must always be secured when the vessel was at sea. The owner thinks he remembers seeing the procedure on the vessel's bulletin board before the accident. After the accident, it has not been possible to verify that such a procedure was posted on board.

1.8.3 Safety management on *Finnøybulk*, one of the shipping company's other vessels

A safety management system had been established for *Finnøybulk*, which had a gross tonnage of more than 500. Since the shipping company was not ISM-certified, the responsibility for implementing and following up this system was delegated to Karmøy

[5] Certificate of Receipt of Application

Skipsconsult Management AS, which was thus the operating company responsible for ISM on behalf of Ryfylke Shipping AS in relation to *Finnøybulk*.

According to the work instructions for deck,[6] all hatch covers and securing devices were to be checked and closed before departure. It was part of the work instructions for the wheelhouse to verify compliance with the work instructions for deck. In addition, hatch coamings, covers and gaskets were to be inspected regularly for damage and corrosion. It was also clear from the wheelhouse instructions that two persons should always be present on the bridge (navigator and lookout) when it was dark and otherwise as required by the situation.

The management system also included procedures for shipboard training and familiarisation.

Transport of dangerous cargo was covered by a separate procedure that referred to the IMDG Code, but no procedure had been established for the carriage of bulk cargoes.

1.9 Technical information about the vessel

1.9.1 History

Finnøyglimt was built at Alfred Hagelstein Maschinenfabrik – Schiffswerft in Lübeck in Travemünde in 1961, as Yard no 603. The vessel was built to sail under the German flag, but acquired the right to fly the Danish flag in 1970. It acquired the right to fly the Norwegian flag in 1974.

In 1984, the vessel was altered so that the deck between the forecastle and poop, as well as the cargo hatch, were raised by 1.00 m. This increased the vessel's moulded depth from 3.015 m to 4.015 m. The vessel's gross tonnage increased from 299.91 to 425.

The vessel was classed with GL[7] until 1986. From 1986 and up until it sank, the vessel was unclassed.

In 1986, the deckhouse on the poop deck was extended to the shipside on both sides. This increased the gross tonnage to 437. The international summer freeboard was reduced from 605 mm to 425 mm, measured from topside deck midship, corresponding to a moulded draught of 3.600 m. The national summer freeboard was reduced to 300 mm, corresponding to a moulded draught of 3.725 m. When loaded to the national summer load line, *Finnøyglimt* had a bow height from the waterline to the forecastle deck of 2 785 mm on even keel. Aft of the forecastle, the vessel had a bulwark with a height of 1 m above the main deck.

The shell plating had been replaced after a grounding in 2007.

Ryfylke Shipping AS bought *Finnøyglimt* from Hagen Sjøtransport at the end of 2007.

In 2009, repairs were carried out of damage resulting from a grounding.

[6] Work instruction no: 07–01
[7] Germanischer Lloyd

At the time of the accident, *Finnøyglimt* had a valid trade certificate for the small coasting trade area. Its normal area of operation was Ryfylke, with one voyage to the Bergen area every other week, on average.

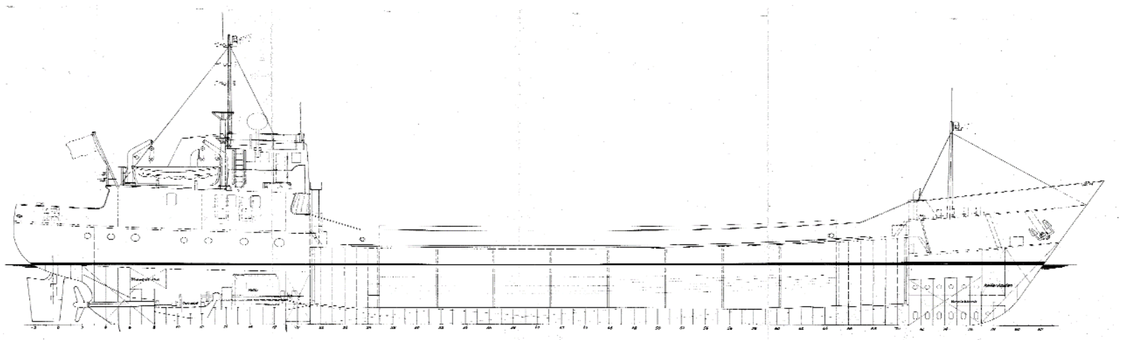

Figure 13: General arrangement drawing on completion of the alteration work in 1984. The vessel had a double bottom with bunker and ballast tanks. The transverse bulkhead in the cargo hold and the excavator on top of the cargo hatches are not shown on the drawing. Nor does the drawing show that the collision bulkhead was extended to the level of the forecastle deck. Source: The Norwegian Maritime Authority

1.9.2 Cargo hold

Finnøyglimt had one cargo hold, divided into two by a transverse bulkhead. The transverse bulkhead was made of steel up to 1.5 metres above the tank top. The upper part of the bulkhead was made of wood. The cargo hold was separated from the shell by a passage on either side under deck. The cargo hold had also been insulated with a view to transporting asphalt. The cargo hold was arranged with bilge wells aft, aft of the lining plates on the starboard and port side. The cargo hold was not equipped with a water level alarm.

1.9.3 Hatch arrangement

The vessel had one cargo hold opening, approximately 20.14 metres long and 5.00 metres wide. The coaming varied in height to accommodate the camber and spring of the deck. The coaming was 950 millimetre high on either side midship, and 630 millimetres high on either side fore and aft. The cargo hatch was arranged with seven hatch covers. The six aftmost covers were pull-wire folding hatch covers operated by a winch. The foremost cover was hinged at the forward end and was lifted and lowered using the excavator. Each hatch cover had four wheels that could run in a longitudinal wheel track on the outside of the compression bar, and the wheel track was equipped with jacks for raising/lowering the covers. The jacks were hydraulically operated with simultaneous operation of all the jacks on both sides.

The covers, consisting of watertight aluminium structures, were approximately 2.893 metres long, 5.266 metres wide and approximately 0.204 metres high. They were reinforced internally with two transverse stiffeners and four longitudinal stiffeners. The thickness of the top and bottom plates, respectively, was 8.0 and 6.0 millimetres. According to the AIBN's calculations, each hatch cover had a volume of 3.038 m^3 and a weight of 0.8951 tonnes. Given that they were watertight, they would float with a draught of 6 centimetres.

The securing arrangement consisted of two securing devices on each side of each hatch cover, plus three or four securing devices at the forward end of the foremost hatch and the aft end of the aft hatch. The cleats had to be hooked on between two lugs that were welded to the hatch covers and then engaged by lifting them up with a crowbar or similar. The pressure against the compression bar could be adjusted by means of a nut at the end of the rod to which the cleats were fastened.

It has not been possible to get hold of drawings of the hatch covers and securing arrangement on *Finnøyglimt* from the shipping company, the hatch manufacturer[8] or the Norwegian Maritime Authority. However, the hatch manufacturer gave the AIBN access to drawings for a vessel[9] having an arrangement corresponding to the one on *Finnøyglimt*. Figure 14 shows a detailed drawing of the securing arrangement.

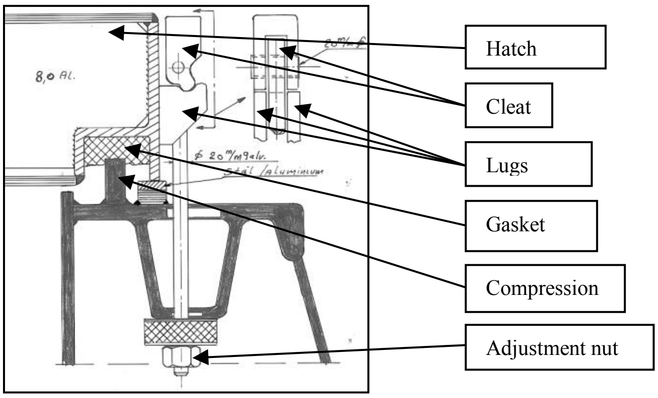

Figure 14: Excerpt of drawing 0-1055 'Hatch cover assembly, M/S Solvind', corresponding to the hatch cover securing arrangement on Finnøyglimt. Source: Kopervik Slip AS

1.9.4 Cargo handling

A new excavator was mounted on top of the cargo hatches in 1994, with a view to handling bulk loads, and transverse and longitudinal levelling of the cargo. The excavator was mounted on a trolley that could move longitudinally along the whole length of the cargo hold. The trolley was secured against accidental longitudinal movement by two straps at the aft end, and by the chains by which it was pulled. The excavator was attached to the trolley with brackets, and the trolley moved on rails, so that both the excavator and the trolley were secured against transverse movement. The trolley and excavator had an estimated aggregate weight of 30 tonnes.

1.10 Cargo, shipper and shipping agent

1.10.1 The shipper and the cargo

The cargo that *Finnøyglimt* carried when it foundered had been loaded at NCC Roads AS in Helle. This facility is located in Forsand Municipality, about 40 kilometres east of Stavanger. The natural aggregate that is quarried is mostly used in the production of concrete and asphalt.

According to the shipper's cargo document, the aft and forward part of the cargo hold were loaded with 430 tonnes of sand (0–8 mm) and 270 tonnes of aggregate (8–16 mm), respectively, in all 700 tonnes. The cargo document that accompanied the cargo in question did not contain any information about the moisture content of the cargo, its

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[8] Kopervik Slip, NO-4261 Kopervik
[9] Formerly named *Solvind* – LAJB, now named *Torvåg*

transportable moisture limit or the specific gravity of the cargo. Nor was the ship's captain or the shipping company provided with any other written information about the properties of the cargo or possible risks.

After the accident, the shipper has informed the AIBN that the moisture content is not checked in connection with every shipment, but that it is around 3% on average. No consideration has been given to a possible transportable moisture limit for the shipment. Nor had any measurements been carried out of the specific gravity of the products in question, but it has been estimated at approximately 1.5 t/m^3 for both sand (0–8 mm) and aggregate (8–16 mm).

1.10.2 The shipper's quality management system

As part of its management system, NCC had prepared a procedure for document handling in connection with loading ships, and a procedure for loading ship cargoes; see Annex F.

The procedure for document handling contained a list of forms that were to be completed and handed over to the ship's captain/responsible officer and the responsible person at NCC's office, respectively. Information about the properties of the cargo was not included in the documents that were to be handed over to the ship.

The procedure for loading ship cargoes contained an overview of tasks to be completed before and during loading, and of matters to be addressed in connection with any nonconformities that were detected relating to cargo quality, technical failure or damage inflicted while the cargo was being loaded/discharged. Among other things, it was stated that the cargo should be watered/sprayed to prevent dust emissions.

1.10.3 The shipping agent

The relevant cargo assignment that Ryfylke Shipping AS received for *Finnøyglimt* was based on an agreement between NCC Roads AS in Helle and Karmøy Grus & Pukk (KGP). The agreement between NCC and KGP mainly applied to the shipment of concrete aggregate to concrete terminals in Hordaland/Rogaland, and KGP was thus an agent for providing relevant tonnage to NCC Roads AS in Helle. There was no direct agreement between KGP and Ryfylke Shipping AS.

In addition to shipping agency services, KGP also has its own shipping business, which includes the carriage of sand, gravel and concrete aggregate.

1.11 Relevant rules and regulations

1.11.1 Overriding requirements for the design, construction, fitting out, operation and supervision of ships

Act No 9 of 16 February 2007 relating to ship safety (the Ship Safety and Security Act) is applicable, among other things, to Norwegian and foreign ships used in commercial activities, regardless of their size. Pursuant to the Act, a ship shall be so designed, constructed and equipped that it, according to its purpose and trade area, provides for the satisfactory protection of life, health, property and the environment. The Ministry issues regulations relating to how vessels shall be designed, built and fitted out in order to meet the above requirements.

Section 6 of the Act states that the shipping company has an overall duty to ensure that the construction and operation of the ship are in accordance with the rules laid down in or pursuant to the Act, including that the master and other persons working on board comply with the legislation.

Section 7 of the Ship Safety and Security Act states that the shipping company shall ensure that a safety management system that can be documented and verified is established, implemented and developed in the company's organisation and on the individual ships, in order to identify and control the risk and also to ensure compliance with requirements laid down in or pursuant to a statute or in the actual safety management system. The contents, scope and documentation of the safety management system shall be adapted to the needs of the company and its activities.

The shipping company shall ensure that the master and other persons working on board are given an opportunity to participate in the establishment, implementation and development of the safety management system.

The Ministry may issue more detailed regulations on the requirements for a Safety Management System, including regulations on:

a) *contents, scope and documentation;*

b) *safety management certificates for ships;*

c) *a document of compliance for safety management for companies; and*

d) *the right for certain ships to deviate from the requirements for a Safety Management System and the right to deviate from the first and second paragraphs when this is required as a consequence of the implementation of the EEA Agreement.*

Pursuant to Sections 42 and 43 of the Ship Safety and Security Act, ships and management systems shall be subject to supervision. The purpose of the supervision shall be to establish whether the ship satisfies the requirements laid down in or pursuant to the Act. Supervision of the management system may include a system audit of the documentation confirming that the shipping company has established necessary and appropriate systematic measures, and a verification confirming that the systematic measures are in place and work in practice, and that, with respect to such measures, the activities are in accordance with requirements laid down by law or regulation.

1.11.2 Regulations relating to construction and fitting out

When the vessel acquired the right to fly the Norwegian flag in 1974, the Regulations of 23 September 1969 relating to the construction of cargo vessels (the Shipbuilding Regulations of 1969) became applicable in connection with the certification. With respect to hulls (design and strength etc.), the Shipbuilding Regulations of 1969 required that ships comply with the rules of the competent inspection body and with regulations and provisions adopted by the Norwegian Maritime Directorate (now the Norwegian Maritime Authority).

However, *Finnøyglimt* was materially altered and her draught increased in 1984, and, in that connection, applicable requirements in the Regulations of 26 November 1979 on the construction of ships (the Shipbuilding Regulations of 1979) were used as a basis. This included requirements for intact stability:

Pursuant to Section 22.2, GZ curves were to be prepared for the following load conditions based on the lightship weight as determined on the basis of an inclining test:

1. *Ship in ballast condition, fully fitted out and with 100% provisions and bunkers.*

2. *Ship in ballast condition as in paragraph 1, but with 10% provisions and bunkers.*

3. *Ship loaded to the summer load line (international and/or national) with even load distribution in all holds including hatches, fully fitted out, with 100% provisions and bunkers, and empty water ballast tanks.*

4. *Ship loaded as in paragraph 3, but with 10% bunkers and, if applicable, water ballast.*

Pursuant to Section 22.2.7, under the above load conditions, the cargo should be assumed to be homogenous and evenly distributed provided that this did not conflict with the purpose of the ship.

Pursuant to Section 6.5.5, the load condition must not result in a forward trim of the ship. If the ship's bow height exceeded the minimum bow height pursuant to Reg. 39 of the Load Line Convention,[10] a forward trim equal to 30% of the exceeding bow height would be acceptable, but in no case must it exceed 0.5% of the ship's length. These provisions relating to forward trim were transferred from the Shipbuilding Regulations of 1969, but they have been left out of subsequent shipbuilding regulations.

Section 6.6.1 stated that the load condition must satisfy the following criteria:

- *The area under the righting lever curve (GZ curve) shall not be less than 0.055 metre-radians up to 30° angle of heel and not less than 0.09 metre-radians up to 40° angle of heel, or the angle of downflooding, if this angle is less than 40°. Furthermore, the area under the GZ curve between the angles of heel of 30° and 40° or between 30° and the angle of downflooding if this is less than 40°, shall not be less than 0.03 metre-radians.*

- *The righting lever (GZ) shall be at least 0.20 metres at an angle of heel equal to or greater than 30°.*

- *At the righting angle's maximum value (maximum GZ) the angle of heel should be greater than 30° and shall never be less than 25°.*

- *The initial metacentric height (GM) shall not be less than 0.15 metres.*

The downflooding angle was defined as the angle of heel at which water could ingress through openings in the hull, superstructures and deckhouses that were not closed with means of weathertight closing in accordance with the Load Line Convention.

[10] The International Convention on Load Lines, 1966

1.11.3 Regulations on Safety Measures etc. on ships

Regulations of 15 June 1987 No 507 concerning Safety Measures etc. on Passenger Ships, Cargo Ships and Lighters include provisions relating to, *inter alia*, hatches, means of closing and stability. Pursuant to Section 10(1), all hatches and means of closing etc. shall meet currently applicable load line provisions at all times, and cargo hold hatch covers shall be properly closed and secured except when the ship is in port.

Pursuant to Section 14(2), it must be ensured during ordinary operation that account is taken of stability information and relevant preconditions for approval of such information, including weathertight and watertight means of closing and load distribution. The ship shall be loaded so that it has sufficient stability under all conditions, and so that the master, after an assessment of, among other things, the ship's manoeuvring properties, can take necessary precautions to achieve a safe trim throughout the voyage based the ship's prevailing load condition.

1.11.4 Regulations concerning the carriage of cargoes on cargo ships and barges

Regulations of 29 June 2006 No 785 concerning the carriage of cargoes on cargo ships and barges (the Cargo Carriage Regulations) are a general set of regulations relating to the transport of cargoes that, because of the special danger they pose to the ship or those on board, may require special precautions to be taken. Pursuant to Section 5 of the Regulations, the carriage of goods in bulk is subject to the provisions to SOLAS[11] and the BC[12] Code, among others.

Pursuant to Section 6 of the Cargo Carriage Regulations, necessary cargo information shall be available during loading operations to ensure safe stowing and transport.

The shipper shall provide the master or his representative with information about the cargo sufficiently in advance of loading to enable the precautions that may be necessary for proper stowage and safe carriage of cargo to be put into effect. Such information shall be confirmed in writing and by appropriate shipping documents prior to loading the cargo on the ship. Electronic information is acceptable.

The cargo information shall include:

a) *in the case of general cargo, and of cargo carried in cargo units, a general description of the cargo, the gross mass of the cargo or of the cargo units, and any relevant special properties of the cargo. Information shall be provided as required in subsection 1.9 of the CSS Code.*

b) *in the case of bulk cargo, information on the stowage factor of the cargo, the trimming procedures, likelihood of shifting including angle of repose, if applicable, and any other relevant special properties. In the case of a concentrate or other cargo which may liquefy, additional information in the form of a certificate on the moisture content of the cargo and its transportable moisture limit;*

[11] International Convention for the Safety of Life at Sea
[12] Code of Safe Practice for Solid Bulk Cargoes

c) *in the case of bulk cargo not classified in accordance with the provisions of SOLAS Chapter VII, but which has chemical properties that may create a potential hazard, in addition to the information required by paragraph b), information on its chemical properties.*

SOLAS Chapter VI Part A contains general provisions and requires the shipper to provide the ship with appropriate information to enable the master to take necessary precautions for proper stowage and safe carriage. For more details on the type of information referred to, the Convention refers to MSC/Circ.663, 'Form for cargo information'. Part B contains specific provisions relating to bulk cargoes that may liquefy when the humidity exceeds a certain limit, and to bulk cargoes that pose a risk because of their special chemical properties. With respect to the former type of bulk cargoes the Convention refers to the provisions of the IMSBC[13] Code, and with respect to the latter type of cargoes the Convention refers to the IMDG[14] Code. The IMSBC Code was published in 2013 and replaces the former BC Code.

IMSBC classifies bulk cargoes into the following groups according to the potential hazard they represent:

- *Group A consists of cargoes which may liquefy if shipped at a moisture content in excess of their transportable moisture limit*
- *Group B consists of cargoes which possess a chemical hazard which could give rise to a dangerous situation on a ship*
- *Group C consists of cargoes which are neither liable to liquefy (Group A) nor to possess chemical hazards (Group B)*

For bulk cargoes in Group A, the transportable moisture limit (TML) is set to 0.9% of the flow moisture point (FMP).

Appendix 1 to the Code describes two types of sand: Foundry sand, potassium felspar sand, quartz sand, silica sand and soda felspar sand are classified as Group C cargoes, while cargoes of heavy mineral sand are classified in Group A. The latter usually consists of a mixture of one or more types of heavy mineral sands, which are characterised by high density and relatively fine grain size.

The IMSBC Code recommends the following measures when transporting heavy mineral sand:

'*The appearance of the surface of this cargo shall be checked regularly during the voyage. If free water above the cargo or fluid state of the cargo is observed during the voyage, the master shall take appropriate actions to prevent cargo shifting and potential capsize of the ship, and give consideration to seeking emergency entry into a place of refuge.*'

The NMA has distributed draft new Regulations on the carriage of cargoes on cargo ships and barges for consultation. In the draft Regulations, references to the BC Code have

[13] International Maritime Solid Bulk Cargoes Code
[14] International Maritime Dangerous Goods Code

been replaced by references to the IMSBC Code. In the former BC Code, no types of sand were placed in Group A.

1.11.5 Regulations on the manning of Norwegian ships

Regulations of 18 June 2009 No 666 concerning the manning of Norwegian ships (the Manning Regulations of 2009) apply to, *inter alia*, Norwegian cargo ships with a gross tonnage of 50 and more. Pursuant to Section 7 of the Regulations, the Norwegian Maritime Authority shall determine for each ship the minimum safe manning, including job specifications and qualification requirements etc. that are necessary to maintain the safety of the ship and those on board and prevent pollution of the marine environment.

Section 8 states that the shipping company shall propose a minimum safe manning level based on, *inter alia*, a safety management system, risk analysis, evacuation analysis, organisation chart, job instructions, the ship's technical standard, and the ship type, size and trade area. The proposed safe manning shall cover all relevant operations, tasks and functions for the safe operation of the ship, including preparing the ship for voyages.

In a communication of 12 July 2010 to the NMA, the shipping company applied for the issuance of a minimum safe manning document for *Finnøyglimt* based on the following:

'If we have understood this correctly, new dispensation certificates are no longer issued in relation to minimum safe manning documents; but, provided that the normal rules on working hours are complied with, it is possible, within the framework of the regulations, to adjust the manning accordingly? In our case, that would mean that a captain, engineer and able seaman are sufficient if the voyage does not exceed eight hours. If it is of longer duration, a chief mate is also required.'

According to the minimum safe manning document issued on 16 July 2010 by the NMA, in addition to the captain, *Finnøyglimt* must be manned with a chief mate, an engineer and an ordinary seaman with the ability to cook. The chief mate could be omitted if a 'daytime arrangement' was in place.

The term 'daytime arrangement' was not formally defined in the minimum safe manning document or in the regulations; when the AIBN contacted the NMA after the accident, however, the following was stated:

'When a daytime arrangement is in place, it means that all the crew on board are on duty at the same time. This means that there is also a limit to how long the vessel can operate in the course of a 24-hour period.

This is governed by the provisions on rest periods, which in turn means that the vessel can only operate for a maximum of 14 hours per 24-hour period. The statutory requirement is 10 hours' rest in the course of a 24-hour period, cf. Section 24 first paragraph of the Ship Safety and Security Act.

In other words, a daytime arrangement means that the vessel is not allowed to operate around the clock.'

1.11.6 Regulations concerning watchkeeping on passenger ships and cargo ships

According to Appendix A Part 3 Section 9 of the Regulations of 27 April 1999 No 537 concerning watchkeeping on passenger ships and cargo ships, the master of every ship is bound to ensure that watchkeeping arrangements are adequate for maintaining a safe navigational watch. Under the master's general direction, the officers of the navigational watch are responsible for navigating the ship safely during their periods of duty, when they will be particularly concerned with avoiding collision and stranding.

According to Appendix A Part 3-1 Section 13, a proper lookout shall be maintained at all times in accordance with rule 5 of the International Regulations for Preventing Collisions at Sea, 1972, and shall, *inter alia,* serve the following purpose:

- *maintaining a permanent state of vigilance, by the use of sight, hearing and other available means, with regard to any significant change in the operating environment,*
- *fully appraising the situation and the risk of collision, grounding and other hazards to navigation, and*
- *detecting ships and aircraft in distress, shipwrecked persons, wrecks, objects in the sea and other hazards to safe navigation.*

According to Appendix A Part 3-1 Section 14, the lookout must be capable of devoting his full attention to the task of keeping a proper lookout, and shall not carry out or be assigned any other duties that could interfere with this task.

It is also stated in Appendix A Part 3-1 Section 15 that the duties of the lookout and helmsperson are separate, and the helmsperson shall not be considered to be the lookout while steering, except on small vessels from which there is an unobstructed all-round view from the steering position, and there is no reduced night vision or other impediment to the keeping of a proper lookout.

1.11.7 Regulations concerning hours of work and rest on board Norwegian passenger and cargo ships etc.

According to Sections 4, 6 and 8 of the Regulations of 26 June 2007 No 705 concerning hours of work and rest on board Norwegian passenger and cargo ships etc., the regular working hours shall be eight hours a day, with one day of rest per week and rest on public holidays. However, the master may require a seafarer to perform any working hours necessary for the safety of the ship, persons on board or cargo, or for the purpose of giving assistance to other ships or persons in distress at sea. Musters, fire-fighting and lifeboat drills and other drills prescribed by or pursuant to law shall be conducted in a manner that minimises the disturbance of rest periods and do not induce fatigue.

1.11.8 Regulation concerning the working environment, health and safety of workers on board ships

Regulations of 1 January 2005 No 8 concerning the working environment, health and safety of workers on board ships (the WEHS Regulations) are designed to ensure that work and free periods on board are arranged and organised with due attention to the safety and physical and mental health of the employees.

The shipping company, the master and other persons working on board shall see to, ensure and contribute to compliance with the regulations in accordance with the Ship Safety and Security Act. The shipping company shall ensure, through its safety management system, that the requirements laid down in the Regulations are complied with. Every individual worker shall receive the necessary training, and it shall be ensured that workers are given and have understood the necessary information about safety hazards.

1.11.9 Regulations relating to safety management systems

Requirements for safety management systems are regulated by the Regulations of 14 March 2008 No 306 relating to safety management systems on Norwegian ships and mobile facilities (the ISM Regulations). The international standard for the safe management and operation of ships and for pollution prevention (the ISM Code) is appended to the Regulations (IMO Resolution A 741 (18)). Among other things, the regulations apply to Norwegian cargo vessels with a gross tonnage of 500 or more.

The purpose is to ensure safety at sea, prevent injuries and loss of human life, and avoid harm to the environment, especially the marine environment, and assets. The shipping company shall ensure safe practice in the operation of vessels, a safe working environment, protection against identified risks and continual improvement of the skills of the personnel involved in the operation of the ship. The safety management system shall ensure compliance with compulsory rules and regulations and that current regulations, guidelines and standards are taken into account.

A safety management system is a structured and documented system that enables a company’s personnel to implement the company’s safety and environmental protection policies effectively. The system is designed to ensure compliance with compulsory rules and regulations, and to ensure that current regulations, guidelines and standards recommended by the organisation (International Maritime Organization – IMO), the authorities, the classification societies and other organisations in the marine industry are taken into consideration.

Pursuant to Section 2 of the Regulations, all shipping companies shall have a safety management system for its organisation and on board for each individual ship in accordance with the ISM Code.

Every company shall develop, implement and maintain a safety management system that includes the following functional requirements:

- *a safety and environmental protection policy;*
- *instructions and procedures to ensure safe operation of ships and protection of the environment in compliance with relevant international and flag State legislation;*
- *defined levels of authority and lines of communication between, and amongst, shore and shipboard personnel;*

- *procedures for reporting accidents and non-conformities;*
- *procedures to prepare for and respond to emergency situations; and*
- *procedures for internal audits and management reviews.*

According to the ISM Code, responsibility for the verification, review and control of a safety management system is divided between several parties.

The flag state or anyone carrying out certification on behalf of the flag state is responsible for the control, verification and certification of safety management systems. It shall check that the company and shipboard management operate in accordance with the approved safety management system.

The shipping company is responsible for conducting internal safety audits to verify that activities relating to safety and the prevention of pollution are in accordance with the safety management system.

The shipping company shall regularly assess how effective the safety management system is and review the system in accordance with procedures established by the company (management review).

The ship's master is responsible for regularly reviewing the safety management system on board, and for reporting any deficiencies to the onshore management (the captain's reviews).

1.11.10 Regulations concerning Survey of Ships etc.

According to Chapter 6 of the Regulations of 15 June 1987 No 506 concerning Survey for the Issue of Certificates to Passenger Ships, Cargo Ships and Lighters and concerning other Surveys etc. (Regulations concerning Survey of Ships etc.), cargo ships with a gross tonnage of 50 or more or a length of 24 metres or more shall have a valid trade certificate for the trade area in which the vessel is to be employed. Certificates are issued by the NMA or whoever it authorises (approved classification societies).

Certificates are issued following surveys for a period of up to five years, with one intermediate survey. Surveys shall be conducted in accordance with the Ship Safety and Security Act and pursuant regulations, and shall include inspections to ensure that the hull, machinery, accommodation area, rescue equipment, fire safety arrangements, fire extinguishing equipment, navigational aids, stability calculations, manning etc. are in compliance with applicable regulations.

1.12 Supervisory activities in relation to the vessel and the shipping company

The NMA conducted an initial survey of *Finnøyglimt* in connection with the vessel acquiring the right to fly the Norwegian flag in 1974, and issued a trade certificate on the basis of the survey.

After that date, renewal surveys have been carried out in order to renew the certificate, in addition to intermediate surveys to maintain the certificate's validity. In that connection, thickness measurements were carried out of the shell and the internal structure in 1992 and 2002. Following the measurements in 2002, deficiencies was issued in relation to the thickness of the collision bulkhead.

The NMA also carried out surveys in connection with the alterations to the ship in 1984 and 1986.

The vessel's stability was last approved by the NMA on 16 March 1999 for a draught of 3.725 m (moulded), corresponding to the national summer freeboard of 300 mm. According to the calculations,[15] which were based on lightship data from an inclining test performed on 19 May 1994, the vessel had an aft trim of 0.007 m in homogenous load condition when fully loaded.

The most recent trade certificate had been issued on 21 September 2007 by the NMA on the basis of a survey of the vessel during the period 16 August–24 August 2007. At that time, some shell plates had been replaced on the vessel following a grounding, and the NMA's survey included thickness measurements of the external hull and internal structure.

An intermediate survey was also carried out in the period 17 August–8 December 2009. The survey included inspection of the repairs made after a second grounding.

In connection with the surveys in 2007 and 2009, deficiencies were issued in relation to, among other things, hatch-cover securing arrangements. The deadline for improvement was set to 'before going into service'.

Apart from this, the NMA's survey in 2009 focused on the need to overhaul all machinery and the propeller. Among other things, the shipping company removed all the engines and sent them to Poland for maintenance.

As the ISM Regulations did not apply to *Finnøyglimt*, the NMA did not check the shipping company's safety management system. Nor has the NMA carried out any unannounced supervisory activities in relation to the shipping company.

1.13 Analysis of the properties of the cargo

1.13.1 General information

According to the IMSBC Code, some bulk cargoes may liquefy if the moisture content exceeds a certain limit. The Code describes the problem as follows:

- *The volume of the spaces between the particles reduces as the cargo is compacted due to the ship's motion;*
- *this reduction of the spaces between the particles causes an increase in the water pressure;*
- *the increase in the water pressure reduces the friction between particles, causing a reduction in the shear strength of the cargo.*

[15] Calculations by Nordvestconsult AS, NO-6001 Ålesund

The phenomenon means that a sliding layer may arise in bulk cargoes so that part of the cargo is shifted if the vessels roll to one side or the other; see Figure 15. The sliding layer is not necessarily horizontal or linear, and the cargo will not necessarily be shifted back to where it came from by an opposite rolling movement. This means that the vessel can develop a dangerous list to one side and suddenly capsize.

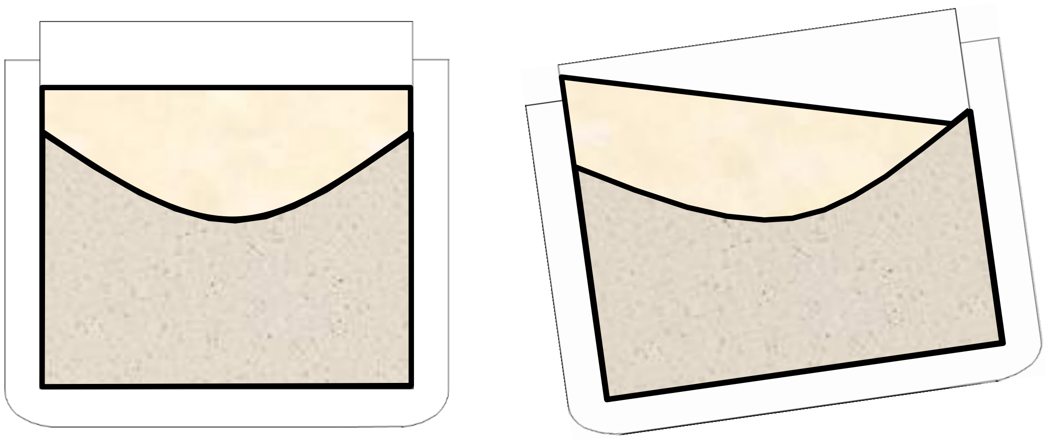

Figure 15: The figure illustrates the sliding layer that may arise in a moist bulk cargo when the particles in the cargo are compacted by the vessel's movements so that the water pressure increases and leads to reduced friction between the particles in the cargo. The reduced friction can lead to shifting of the cargo. Illustration: AIBN

The phenomenon can also occur when the cargo has been levelled out, if the moisture content of the cargo exceeds the FMP.

1.13.2 Examination of the cargo on board *Finnøyglimt*

After the accident, the AIBN commissioned SINTEF to conduct relevant analyses of the properties of the sand and the aggregate.

One important conclusion in the SINTEF report (see Annex D) was that the addition of moisture would 'liquefy' the sand, i.e. that a layer would form in which friction between the sand particles was reduced. The aggregate, on the other hand, did not have this property.

SINTEF's analyses showed that the sand had a flow moisture point (FMP) of 11.5%, which means that, if the moisture content of the sand reached this level and the sand was exposed to movements, it could shift to one side. On this basis, SINTEF concludes its report by recommending that the sand in question should have a transportable moisture limit (TLM) of 10.4% of its dry weight.

It was also concluded in the report that, with the moisture content they had when they were received at the laboratory (5,4 % and 0,8 % of dry weight, respectively), the sand and aggregate had angles of repose of 55 and 41 degrees, respectively; see Table 1.

Table 1: Overview of the cargo properties. Source: SINTEF Building and infrastructure/geotechnical engineering.

	Sand 0–8N	Sand 8–16N
Dry density, ρ_d	1.75	1.5
Grain density, ρ_s	2.63	2.65
Angle of repose	55.0 degrees	41.0 degrees
Angle of friction	42.5 degrees	-
Porosity, n	0.33	0.43
Permeability, k	$2.25 \cdot 10^{-2}$ cm/sec	37 cm/sec
Measured moisture content, w	5.4% of dry weight	0.8% of dry weight
Flow Moisture Point (FMP)	11.5% of dry weight	-

1.14 Investigations into the vessel’s intact stability

As part of its investigation after the accident, the AIBN has also reviewed *Finnøyglimt’s* stability characteristics. Our stability calculations are based on existing drawings of the vessel, the results of inclining tests carried out on 20 May 1994 at Vegsund Slip, the results of SINTEF’s analyses of the cargo properties, NCC’s information about cargo quantities, and information obtained through interviews with the crew. Stability calculations have been carried out for:

- Intact load conditions without water ingress. In that connection, a simplification was made in that the load condition on departure was assumed to be virtually the same as when the vessel foundered. The calculations take into account that *Finnøyglimt* consumed fuel oil between Helle and the position in which it foundered, and also that it filled five tonnes of freshwater in Storasund. The fuel oil consumption has very little effect on the vessel’s stability characteristics, however.

- Load conditions with different degrees of water ingress in the cargo hold, shifting of the aggregate in the forward part of the cargo hold and shifting of the sand in the aft part of the cargo hold.

- ‘Regulated load conditions’, including ballast condition and homogenous load condition when fully loaded.

The calculations show that, on departure from Helle/Storasund, *Finnøyglimt* had a mean moulded draught of 3.588 m and a forward trim of 0.44 m; see load condition 8. The calculations show that the vessel’s stability was satisfactory, see Figures 16, 17 and 18. The fact that the hatches were not secured was not taken into account.

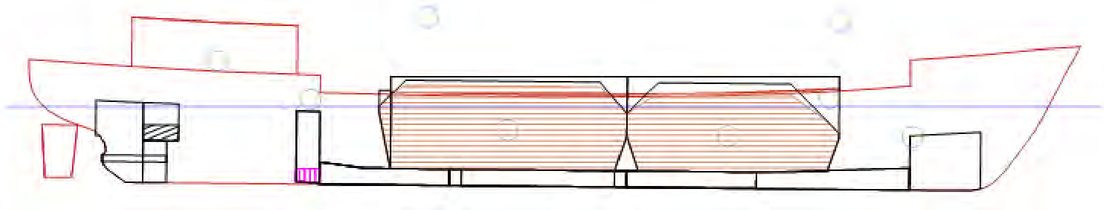

Figure 16: Illustration of the vessel's load condition on departure from Helle/Storasund. Source: AIBN

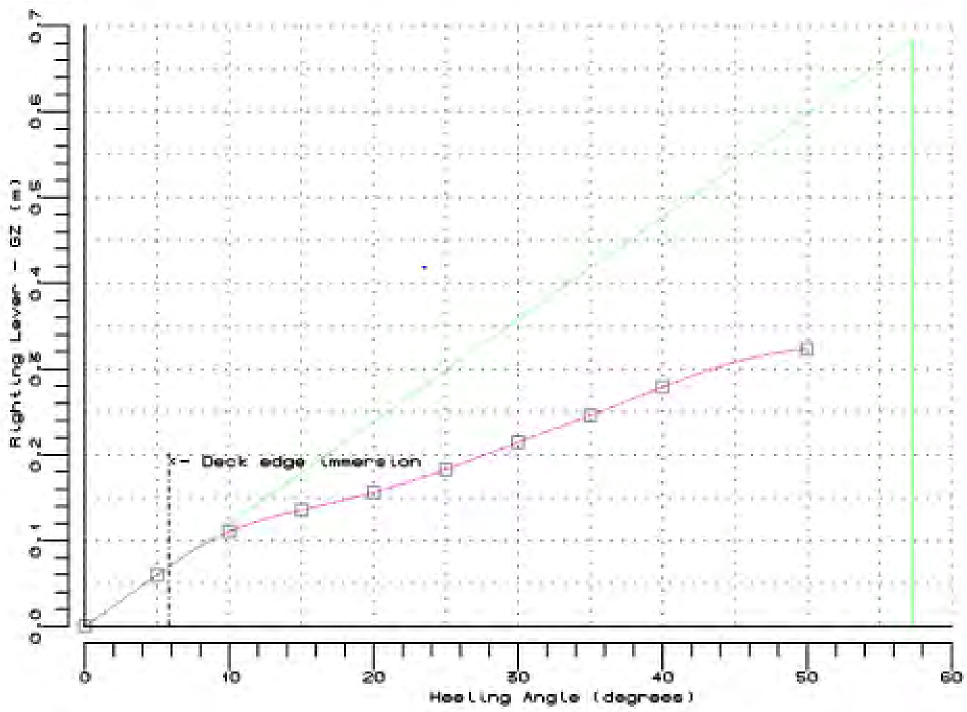

Figure 17: Righting level curve (GZ) on departure from Helle/Storasund. Source: AIBN

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Concl-usion
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.323	OK
GZAng	Angle at which max. GZ occur, ϑ		: 25.00 °	50.000	OK
GMMin	Minimum GM		: 0.15 m	0.684	OK
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.066	OK
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.109	OK
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.043	OK

ß : flooding angle
ϑ : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : OK

Figure 18: The vessel's stability on departure from Helle/Storasund. The fact that the hatches were not secured was not taken into account. Source: AIBN

The calculations also show that, with water in the cargo holds, the stability and buoyancy of *Finnøyglimt* would have been reduced, and the forward trim would have increased. Despite the fact that the aft part of the cargo hold was almost fully loaded, a shifting of the sand cargo would have caused the vessel to list.

Concerning what are known as the 'regulated load conditions', i.e. those load conditions that, pursuant to the applicable regulations, were to be documented and submitted to the NMA for control, the calculations show that the vessel, by use of water ballast, had satisfactory stability in ballast condition. *Finnøyglimt* did not, however, meet the relevant criteria in homogenous load condition when fully loaded to the international draught of 3.6 m and the national draught of 3.725 m, respectively. The calculations also show that the vessel in departure conditions trimmed to much forward when homogenously loaded to both the international and national draught. The reason why these calculations deviate from those that were approved by the Norwegian Maritime Directorate (now known as the Norwegian Maritime Authority) on 16 March 1999 in terms of trim, is that the longitudinal centre of gravity of the cargo used in the approved calculations was incorrect.

The stability calculations are enclosed as Annex E. Because the calculation program that was used shows the vessel's initial stability when inclined to starboard, the vessel has also been inclined to starboard in the enclosed calculations. *Finnøyglimt* was symmetrical around the centre line, so that the result of a starboard list would be identical to the result of a port list. In reality, the vessel listed to port.

1.15 Implemented actions

Neither the shipping company nor the NMA has implemented any special measures after the accident.

1.16 Relevant previous accidents

1.16.1 The foundering of the cargo vessel *Langeland*

Early in the morning on 31 July 2009, in rough weather, the Norwegian-registered cargo ship *Langeland* foundered in the Kosterfjord off the west-coast of Sweden. The vessel was en route from Karlshamn in Sweden to Moss in Norway with a bulk cargo of crushed stone. The whole crew of six died when the ship sank.

The AIBN's investigation indicated that the vessel gradually took on water through the cargo hatches as a consequence of the hatch covers not being secured. The vessel lost buoyancy in the foreship due to water entering the cargo hold and, in combination with transverse and longitudinal shifting of the cargo, this caused the vessel to sink, bow first.

Four safety recommendations were submitted in connection with the AIBN's report after the accident,[16] of which the following recommendations related to limitation of forward trim and securing of hatch covers:

Safety Recommendation MARINE No 2012/04T

The Accident Investigation Board's investigations have discovered that the Langeland's stability calculations were imprecise and made without considering its longitudinal trim. That resulted in the vessel being built without enough reserve buoyancy and with the forward cargo bulkhead positioned too far forward, thus significantly reducing the vessel's ability to survive in terms of withstanding considerable cargo shifting along the length of the ship.

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[16] Report Marine 2012/08 dated 5 June 2012

The Accident Investigation Board Norway advises the Maritime Directorate, to instruct ships which have not had calculations prepared with approved software, to provide a full new set of trim and stability documentation.

In response to the question of how the recommendation has been followed up, the AIBN was told that the NMA considers it inexpedient to instruct existing ships to carry out new stability calculations if the ships have not been altered. In order to fulfil the intention of the recommendation, the NMA has prepared a safety notice that will be distributed to corresponding ships.

Safety Recommendation MARINE No 2012/05T

At the time the Langeland was built (in 1971), there were provisions on maximum forward trim/minimum bow height under theoretical full load conditions with a homogenous load, but there are no such requirements in the current cargo ship regulations. This means that vessels built/being built since these provisions were removed (in 1987) may have been or will be designed with design errors corresponding to the errors on the Langeland.

The Accident Investigation Board Norway advises the Maritime Directorate to reintroduce the provisions for cargo ships relating to maximum forward trim/minimum bow height for load conditions with homogenous load.

In response to the question of how the recommendation has been followed up, the AIBN was told that the functional requirement for bow height has not been changed in the NMA's opinion.

Safety Recommendation MARINE No 2012/07T

The loss of the Langeland shows that securing hatches is especially safety-critical. The AIBN has reason to believe that hatches are not battened down properly on many vessels, but is unable to establish how common this practice is at the shipping company in question or in the Norwegian cargo fleet generally.

The Accident Investigation Board Norway would advise the Maritime Directorate to take steps to increase awareness of the risk factors that may be involved in not securing hatches properly.

As a follow-up to these recommendations, the NMA is considering entering into a dialogue with the Norwegian Coast Guard with a view to establishing a scheme for inspection of ships at sea.

1.16.2 Man over board accident on the cargo ship *Nysand*

On the evening of 24 October 2008, while the crew of *Nysand* were preparing for departure from Forusstranda in Stavanger, the vessel's ordinary seaman fell over board and died.

Among other things, the AIBN's investigation found that there were deficiencies in the shipping company's safety management system. The investigation also showed that the regulations do not define the scope of safety management systems for cargo vessels with a gross tonnage of less than 500.

Two safety recommendations were submitted in the AIBN's report following the accident,[17] of which the following recommendation related to requirements of the safety management system:

Safety Recommendation MARINE No 2010/24T

No safety management system had been established on board Nysand. The Ship Safety and Security Act requires the shipping company to establish a safety management system for the operation of ships, but there are currently no specifications for the scope of safety management systems for cargo ships of less than 500 gt.

AIBN recommends that the Norwegian Maritime Directorate should prepare a specification for the scope of safety management systems for cargo ships of less than 500 gt.

As a follow-up to the recommendation, the NMA is drafting new regulations relating to safety management systems for vessels with a gross tonnage of less than 500. The regulations will thus set out requirements for safety management systems for shipping companies and ships that are covered by Section 7 of the Ship Safety and Security Act, but not by the ISM Regulations. The NMA aims to have the draft regulations ready for an external consultation round in the course of 2014.

[17] Report Marine 2010/09 dated 20 October 2010.

2. ANALYSIS

2.1 Objective

The aim of the analysis has been to describe the most likely chain of events that caused *Finnøyglimt* to founder at Sletta just before midnight on 7 October 2011, and to discuss the most important factors that contributed to the incident.

Relevant underlying causes have also been assessed, and, together with the analysis of the chain of events, this assessment forms the basis for safety recommendations with a view to prevent similar accidents from occurring in future.

2.2 Assessment of the chain of events

In order to be able to complete the description of the chain of events and determine what factors contributed to the foundering of *Finnøyglimt*, the AIBN has taken as its point of departure available factual information, including information obtained during interviews with the survivors, observations made in connection with the ROV examination of the wreck, analyses of the vessel's watertight integrity and stability and the properties of the cargo, in addition to weather and sea conditions.

2.2.1 Assessments of the wreck and the surrounding seabed

In the AIBN's view, observations made of the wreck with the aid of the ROV indicate that *Finnøyglimt* sank and hit the seabed while listing to port. Its masts were bent/broken forward, and the AIBN believes that this indicates that *Finnøyglimt* hit the seabed bow first.

The absence of marks in the seabed sediments aft of the stern is interpreted to mean that *Finnøyglimt* was moving forward at low speed at the time of the accident. Damage in the form of deformation/vertical indentation of the lower part of the hull on the starboard side along the whole length of the ship suggests that *Finnøyglimt* hit the seabed with great force. The port side is assumed to have been correspondingly damaged, but any such damage was not visible due to the list.

Observations of the wreck after it foundered confirmed the information that the AIBN obtained through interviews with the survivors; namely, that none of the cargo hatch covers had been secured.

As the hatch covers were buoyant, they would, in principle, not have gone down when *Finnøyglimt* sank. However, hatch cover no 1 was attached to the hull in that it was hinged at the forward end. Hatch covers nos 4, 5, 6 and 7 were most likely held in place partly by the excavator and the trolley and partly by the wire for the folding mechanisms for the hatches. The two forward folding hatch covers (nos 2 and 3) were probably left hanging on the wire behind the vessel when it sank. The AIBN believes that the covers collapsed from the water pressure when they sank. The forward cover on the wire (cover no 2) probably came loose from the wire before the vessel hit the seabed, and the AIBN assumes that it was this cover that was found 85 metres aft of the bow of the wreck. The hatch cover that was found lying against the wreck's starboard side was probably cover no 3.

The sand had shifted to port, and the aggregate had shifted both forward and to port. Some aggregate had been thrown over the coaming and was lying on the port side of the deck between the coaming and the bulwark. The AIBN believes that this suggests that the aggregate was thrown to the port side as the vessel hit the seabed. If the aggregate had been thrown over the coaming before *Finnøyglimt* went down, it would probably have disappeared while the vessel was sinking.

The AIBN believes that the position of the rudder indicates that the master tried to turn to starboard before the vessel sank.

2.2.2 Assessment of the vessel's watertight integrity and the probability of water ingression

The sea was heavy when *Finnøyglimt* came into open waters at Sletta on the evening of 7 October 2011. The significant wave height was initially 4.5 m, but the waves were also affected by the topographical conditions in the area of Sletta. Seen in conjunction with the vessel's bow height of 2 686 mm to the forecastle deck and freeboard of 432 mm to the main deck, cf. load condition 8, the AIBN believes that *Finnøyglimt* was exposed to considerable amounts of green sea on deck. The one-metre high bulwark probably prevented the water from being drained away immediately. The cargo hatch covers, which had not been secured, consisted of aluminium structures that had great buoyancy in relation to their weight. The coamings were the same height as the bulwark and, under the prevailing conditions, there was most likely enough water on deck to lift the covers from the compression bar, causing water ingress in the cargo hold. As the vessel started to list and its freeboard was reduced, the likelihood of water ingress increased. The port side was more affected than the starboard side, because the waves hit the port side of the bow.

When the captain communicated with Kvitsøy VTS just before the ship went down, he said that the vessel was taking in water in the cargo hold. The AIBN has been unable to determine the time at which he became aware of the water ingress. The captain was alone on watch and cannot have physically inspected the cargo hold. His conclusion was probably based partly on the changes he noticed in relation to the vessel's freeboard and trim and partly on visual observations of green sea on deck made from the wheelhouse. He was probably also aware that the cargo hatch covers had not been secured.

The fact that no holes or cracks in the hull were found in connection with the ROV examinations makes it unlikely that water ingress occurred between cracks in the shell as a result of the hull structure collapsing. In this connection, the AIBN also assumes that the vessel, despite its age, may have been in satisfactory condition in terms of strength. Both the collision bulkhead and the shell plates had been replaced in recent years, and the NMA measured the thickness of both the shell and the internal structure in 1992, 2002 and 2007.

The AIBN is therefore of the opinion that *Finnøyglimt* most likely suffered water ingress in the cargo hold through leaking cargo hatch covers.

The hatches on the forecastle deck had not been secured either. The AIBN considers it likely that flooding of the forecastle and forepeak via these hatches may have caused the ship to founder more quickly.

2.2.3 Assessment of the cargo's properties and the probability of cargo shift

During the conversation with Kvitsøy VTS just before the ship foundered, the captain stated that *Finnøyglimt*, in addition to taking in water in the cargo hold, was listing to port. Since water in the cargo hold would not have caused the vessel to list permanently, and the investigation did not uncover any cracks or weaknesses in the hull that could have caused asymmetrical water ingress in other buoyancy volumes, the AIBN believes cargo shift to have been the most likely cause of the list.

Tests carried out by SINTEF show that the sand and aggregate had angles of repose of 55 and 41 degrees, respectively. The AIBN considers it unlikely that bulk cargoes with such great angles of repose would shift during a sea voyage, provided that they were dry and evenly levelled out.

However, SINTEF's analyses show that, in moist condition, the sand, unlike the aggregate, would 'liquefy' when exposed to vibrations and movement. The report concludes that the sand had a flow moisture point (FMP) of 11.5%.

According to the shipper, the moisture content was not measured before the sand was taken on board *Finnøyglimt*; based on experience, however, the shipper estimated the moisture content to be approximately 3%. According to SINTEF, the moisture content of the samples that were sent for analysis after the accident was 5.4% for the sand and 0.8% for the aggregate. This suggests that, at the time when it was loaded, the moisture content of the sand may have been somewhat higher than estimated by the shipper.

If we assume that SINTEF's measurement of the moisture content in the sand and the aggregate is representative of the moisture content at the time of loading, *Finnøyglimt* had taken on board 408 tonnes[18] of sand and 268 tonnes[19] of aggregate (dry weight) in Helle.

An increase in the moisture content of the sand cargo from 5.4% to the flow moisture point (11.5%) would require the addition of 24.89 tonnes of water. Assuming that the sand and the aggregate cargoes were subject to the same amount of flooding, i.e. that a total of approximately 47.29 tonnes of water were added, and that the duration of green sea on deck that could lead to water ingress was 20–25 minutes, the average flooding rate would have been in the range of 1.8–2.3 cubic metres per minute. The duration of 20–25 minutes corresponds to the time it took *Finnøyglimt* to sail from Gardsøya to Tømmerflua.

Based on information about the prevailing sea and weather conditions, and the assessment of the vessel's watertight integrity, the AIBN believes the estimated average flooding rate to be realistic.

On that basis, it is highly probable, in the AIBN's opinion, that the sand cargo shifted before the ship foundered. It is also highly probable that shifting of the sand cargo caused *Finnøyglimt* to list as reported by the captain before he made the decision to turn around and go back to Haugesund.

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[18] 430 tonnes reduced by a water content of 5.4%
[19] 270 tonnes reduced by a water content of 0.8%

As far as the aggregate is concerned, it was observed to have shifted forward and to port. The AIBN believes that the transverse shift may have occurred when the vessel hit the seabed. The longitudinal shift may have occurred when the vessel hit the seabed, but it may also have taken place just before the ship foundered, since the aggregate had not been levelled out in the alongship direction.

2.2.4 Assessment of the vessel's trim and stability when it foundered

According to the AIBN's calculations, *Finnøyglimt* had satisfactory stability on leaving Helle/Storasund, if we disregard the fact that the hatches had not been secured. As described in section 2.2.2, however, the AIBN believes that water ingress in *Finnøyglimt's* cargo hold was most probably a result of green sea on deck entering the cargo holds through leaking hatches.

There was a high probability that the sand would shift when the moisture content reached 11.5%. The stability calculations show that 11.5% moisture (24.89 tonnes of water in the sand and 22.40 tonnes of water in the aggregate) and a shift of the sand cargo, would cause the vessel to list 3.5°; ref. load condition 11. In this condition, the vessel would have had a freeboard of 29 mm and a forward trim of 0.59 m. The vessel would have had stability reserves, but would not have met applicable stability criteria.

The AIBN assumes that the water ingress increased from this point onwards and that the sand's moisture content may have reached saturation point (78.31 tonnes of water). If it is assumed that a corresponding amount of water had leaked into the forward part of the cargo hold, there would have been 52.79 tonnes of water in the aggregate, ref. load condition 12. Calculations show that, in this condition, the vessel would have had a list of 4.0°. The main deck would have been under 207 mm of water at the ship's side, and the vessel would have had a forward trim of 0.77 m. The vessel would have had stability reserves, but would not have met applicable stability criteria.

Calculations show that 107.05 tonnes of water in the aft part of the cargo hold and 78.66 tonnes of water in the forward part of the cargo hold (saturated aggregate), combined with a shift of the sand cargo, would have caused the vessel to list 3.2°. In this condition, the main deck would have been under 299 mm of water at the ship's side, and the vessel would have had a forward list of 1.01 m. The vessel would have had stability reserves, but would not have met applicable stability criteria; ref. load condition 24. The reason why the list would be reduced in this condition is that the added water would accumulate on the opposite side to the shifted sand cargo. Calculations show that, if the entire space above the shifted sand cargo had been flooded with water, the list would have increased to 5.4°; ref. load condition 25.

With both the forward and aft part of the cargo hold completely flooded with water, and a shift of the sand cargo, the vessel would have had a list of 12.1°. The main deck would have been under 1 184 mm of water at the ship's side, and the vessel would have had a forward trim of 1.44 m. In this condition, the top of the hatch coaming would have been 130 mm under water. The vessel would have had stability reserves, but would not have met applicable stability criteria; ref. load condition 26. This condition shows a vessel that is about to sink. The air pipe on the main deck and the access hatch in the deck aft of the forecastle would have been submerged, which could have caused flooding of the double bottom tanks, among other things. Unsecured hatches on the forecastle could have caused the forecastle and the forepeak tank to be flooded with water.

The AIBN has also made calculations based on a shift of the aggregate alone and a shift of both the sand and aggregate together. The calculations show that these scenarios would have left the vessel with such a great list and so little freeboard that the AIBN considers them highly unlikely. As the properties of the aggregate also make a transverse shift unlikely, the AIBN does not believe that the aggregate shifted to the side. As the aggregate was not levelled out in the longitudinal direction, however, a longitudinal shift may have taken place. If so, it would have resulted in a minimal increase in trim.

2.2.5 Assumed chain of events

The AIBN believes that *Finnøyglimt's* voyage was a normal one from the time that it left Helle until it passed west of Gardsøya island at the northern end of Karmsundet sound.

The investigation has shown that the vessel had satisfactory stability on leaving Helle/Storasund, if we disregard the fact that the cargo hatches had not been secured. However, a forward trim of 0.44 m and a freeboard of 432 mm meant that the vessel was more exposed to green sea on deck than it would have been without the forward trim. In addition, the forward trim meant that the vessel's buoyancy in the foreship was reduced, which in turn reduced the vessel's ability to rise out of the water and skirt the waves.

Finnøyglimt probably started to take in water in the cargo hold through leaking hatches as it passed Gardsøya at approximately 22:37; see Figure 19. Here, the vessel encountered bigger waves smashing against the port side of the bow as a result of the wind waves. This may have caused green sea on deck, leading to water ingress in the cargo hold. The water ingress meant that the vessel's forward trim gradually increased, at the same time as its freeboard was gradually reduced. The vessel was also exposed to longer swells against its side.

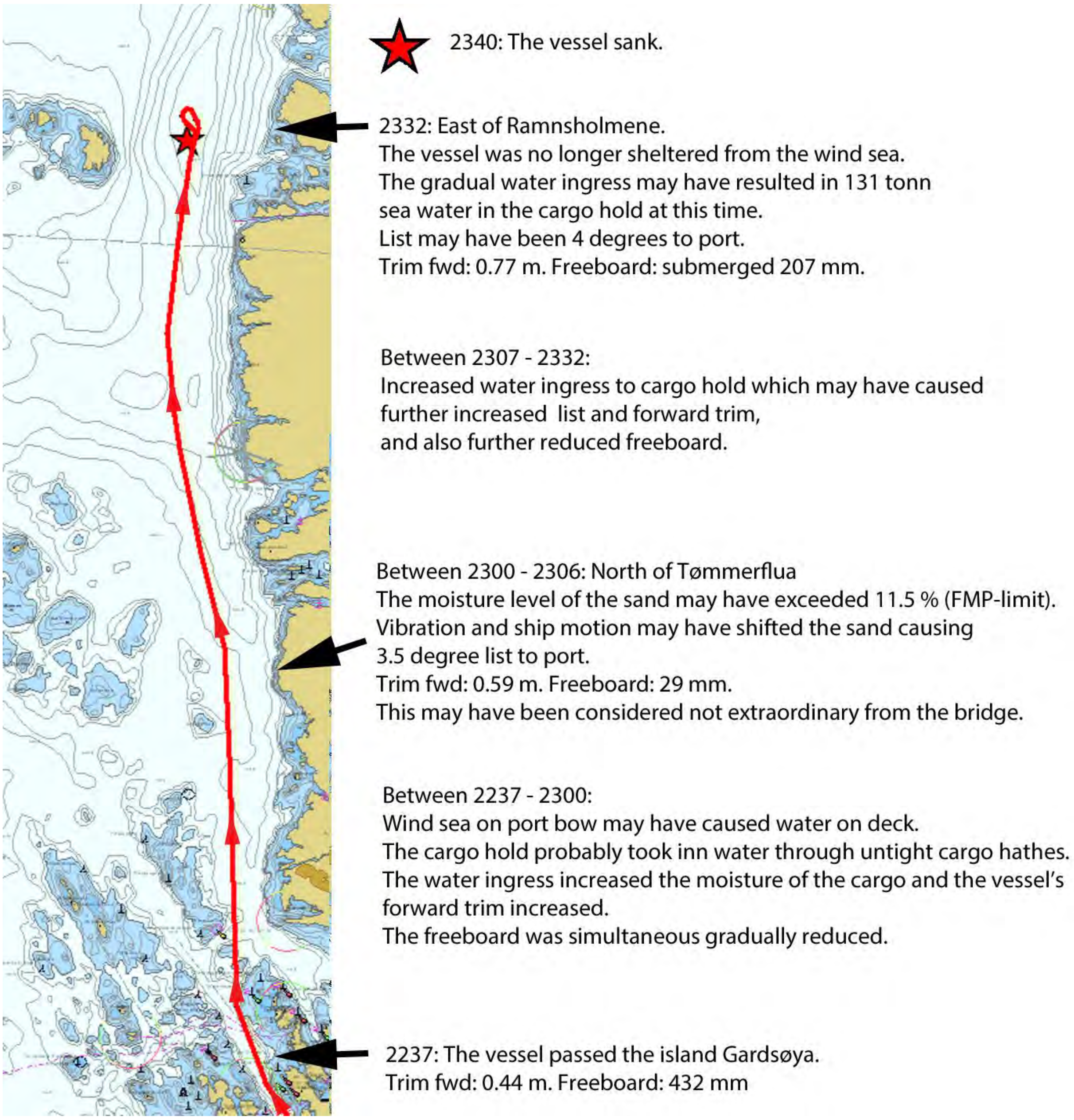

Figure 19: Illustration of assumed chain of events. Based on charts/maps provided by: the Norwegian Mapping Authority, Geovekst and municipalities) Illustration: AIBN

The ingress of water increased the moisture content of the sand to 11.5% (FMP). Vibrations and movement in the vessel caused the water pressure in the sand to increase, thus reducing the friction between the sand particles. As a result of the vessel's rolling movements, the sand probably shifted to port in the sliding layer that had been created. The cargo shift may have taken place at approximately 23:00–23:06 as the vessel was passing Tømmerflua. It can be seen from the AIS data that the vessel was subject to several major accelerations while passing through this area.

The shifting of the sand gave *Finnøyglimt* a list of 3.5°. At the same time, the vessel had developed a forward trim of 0.59 m, and its freeboard had been reduced to 29 mm. It is possible that this list was so small that it went unnoticed by the captain. It is also possible that the captain noticed the list, but that he did not perceive the situation as dramatic.

After the vessel had passed Tømmerflua, the water ingress increased and caused a further increase in the list and forward trim, and a further reduction of the freeboard. The AIBN believes that, before the vessel started changing course in order to turn around at approximately 23:32, the water ingress must have escalated considerably as a result of the increase in the list and forward trim, and the reduced freeboard. At the same time, the vessel gradually moved into an area that was more sheltered from the wind waves, and the swells against the vessel's side diminished.

When the captain started to turn the ship near Ramnsholmene at 23:32, the amount of water may have increased to 78.31 tonnes (the sand's saturation point) in the aft part of the cargo hold and to 52.79 tonnes in the forward part of the cargo hold. If that was the case, the list will have increased to 4°. The forward trim was probably 0.77 metres, and the main deck was probably submerged under 207 mm of water. In this area, the vessel was no longer sheltered from the wind waves. The fact that the vessel, in such a condition, encountered 4.5-metre high waves smashing against the port side of the bow may have been perceived as dramatic by the captain and been one of the reasons why he decided to return to Haugesund. Details of the last few minutes of the chain of events are summarised in Figure 20.

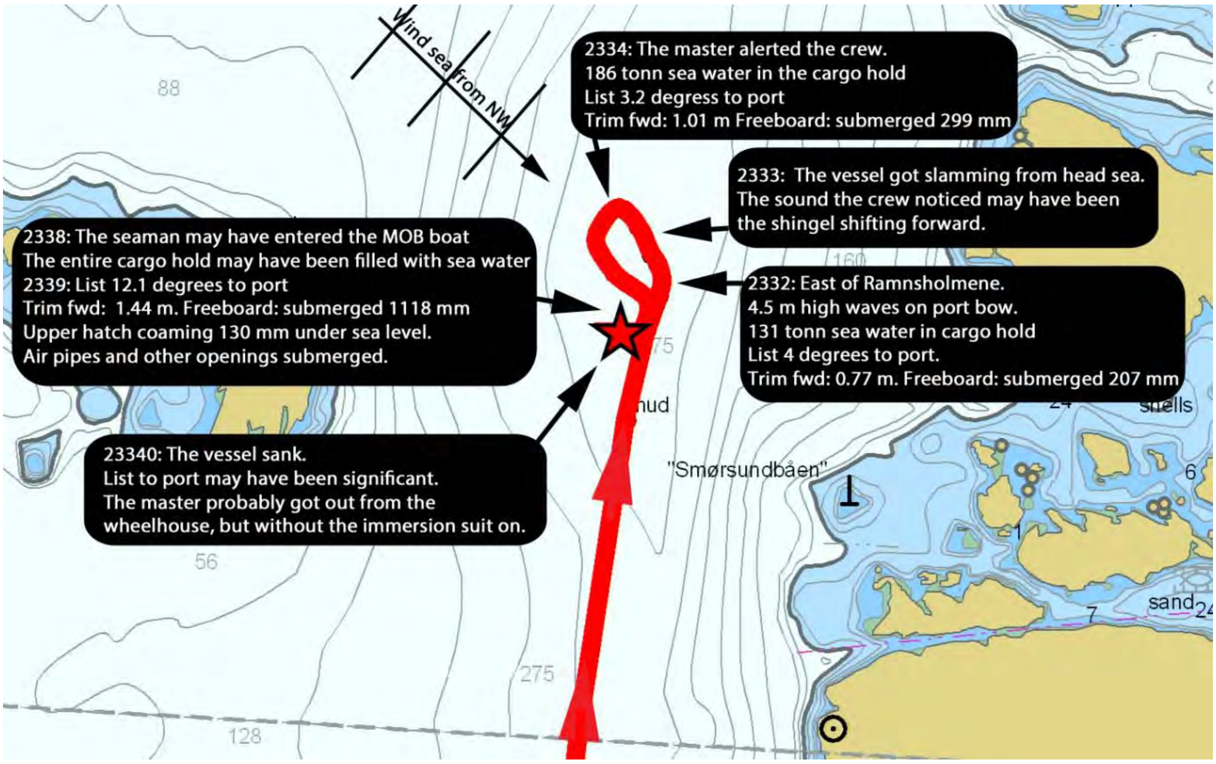

Figure 20: Assumed chain of events during the final minutes before the vessel foundered. Based on charts/maps provided by: the Norwegian Mapping Authority, Geovekst and municipalities. Illustration: AIBN

Just after 23:32, *Finnøyglimt* was moving with the bow against the wind. This is probably when the crew registered the impacts of the vessel hitting the troughs of the waves. The AIBN cannot say for certain what caused the metallic noise that the crew heard after these impacts, but it cannot be ruled out that it was the aggregate shifting forward. If such a shift occurred, it would have resulted in a minimal increase in the trim.

The captain announced over the intercom that there was something wrong with the vessel. He then called Kvitsøy VTS at 23:34. Kvitsøy VTS had been monitoring the voyage and already suspected that something was wrong. At this time, the amount of water may have increased to 107.05 tonnes in the aft part of the hold and to 78.66 tonnes in the forward part of the hold (saturated aggregate). The vessel may have had a list of 3.2°. The forward trim had increased to 1.01 m, and the deck was under 299 mm of water; ref. load condition 24. The reason why the list would be reduced in this condition is that the added water would accumulate on the opposite side to the shifted sand cargo. The list would soon have increased to 5.4°, however; ref. load condition 25.

Finnøyglimt turned to port, past the course that it would be expected to take in order to return to Haugesund, until it was heading southeast. The captain probably tried to turn to starboard to correct the course. The rudder angle had little effect, however, partly because the waves were smashing into the vessel abaft the beam, partly because of the forward trim and partly because the vessel was listing. This resulted in a change of course of more than 250°, rather than the intended 180°.

By the time the able seaman and the engineer went into the MOB boat, probably after 23:38, the cargo hold may have been completely flooded with water. At that time, *Finnøyglimt* may have had a list of 12.1°. The main deck would have been under 1 184 mm of water at the ship's side, and the vessel would have had a forward trim of 1.44 m. An illustration of the condition is provided in Figure 21.

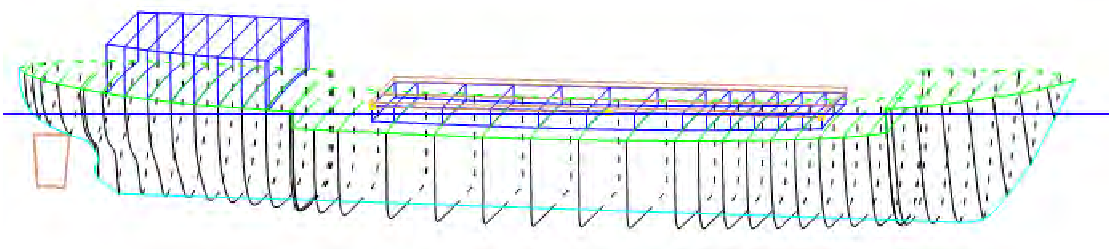

Figure 21: Illustration of load condition with the cargo hold completely flooded with water. The condition is shown with a starboard list. In reality, the vessel listed to port. Finnøyglimt was symmetrical around the centre line, so that the result of a starboard list would have been identical to the result of a port list. Source: AIBN

In this condition, the top of the coaming would have been 130 mm under water, and the air pipe and other openings in the main deck would have been submerged, which could have led to flooding of, among other things, the double bottom tanks. After that the forecastle and the forepeak tank were also flooded with water.

Finnøyglimt was now foundering. According to the able seaman, *Finnøyglimt* went down in the course of barely a minute after the top of the coaming on the cargo hatch came under water. The AIBN assumes that *Finnøyglimt* sank at approximately 23:40.

At the time when it foundered, *Finnøyglimt* was moving on a west-southwesterly course at a very low speed. The AIBN believes that *Finnøyglimt* sank with a port list. The captain was probably able to get out of the wheelhouse, but unable to put on his survival suit.

Hatch covers nos 2 and 3 were left hanging behind *Finnøyglimt* on the wire for the covers' folding mechanism when the vessel sank, and they collapsed from the water pressure. Hatch cover 2 came loose from the wire before the vessel hit the seabed and was left lying 85 metres aft of the bow of the wreck. Hatch cover 3 ended up leaning against the starboard side of the wreck.

The aggregate in the foremost part of the cargo hold was probably thrown towards the port side as a result of the list when the vessel hit the seabed.

2.3 Immediate and contributory causes

The AIBN believes that *Finnøyglimt* foundered after gradually losing buoyancy as a result of water ingress in the cargo hold. The water probably entered the cargo hold through leaking hatches. The question of why the cargo hatches were not secured before departure is discussed in section 2.4.

Finnøyglimt probably took in a considerable amounts of green sea on deck, which increased the risk of water ingress on the voyage in question. The amount of green sea on deck was particularly high because of the ship's forward trim. The question of why the vessel had a forward trim is discussed in section 2.5.

The situation deteriorated further when the vessel started to list. The list probably occurred as a result of the sand shifting. The AIBN's investigation has found that the sand that was shipped from the NCC's facility had the property that it would liquefy when the moisture content reached 11.5% of the dry weight. Special precautions should therefore have been taken when transporting this sand in bulk. The question of why the crew were not aware of this is discussed in section 2.6.

2.4 Securing of cargo hatch covers

The cargo hatch covers were not secured before departure as prescribed by regulations. On the voyage in question, this involved a risk of water ingress through leaking hatches.

2.4.1 The manning of the vessel

The securing arrangement for the cargo hatches on *Finnøyglimt* consisted of two securing devices on either side of all seven cargo hatch covers, plus three or four securing devices at the forward end of the foremost hatch and at the aft end of the aftmost hatch – in all, approximately 35 securing devices. The AIBN assumes that it takes about one minute to apply/disengage one of the securing devices. Based on this, it will take more than an hour to compete this task in connection with each loading and unloading operation. The AIBN believes that, in a hectic situation, the manning of the vessel may have had a bearing on whether or not this task was performed. In the AIBN opinion, it cannot be ruled out that the manning of the vessel in this case affected the preparations for the voyage.

According to the minimum safe manning document issued by the NMA, *Finnøyglimt* must, in addition to the captain, be manned with a chief mate, an engineer and an ordinary seaman who could cook. According to the document, the chief mate could be omitted if a daytime arrangement was in place.

The term 'daytime arrangement' was not defined in the minimum safe manning document or in the regulations. When the AIBN contacted the NMA after the accident, it was informed that a 'daytime arrangement' means that the vessel is not allowed to operate around the clock. As a result of the rules on rest periods, the vessel can operate for a maximum of 14 hours during a 24-hour period.

In the application to be issued with the relevant minimum safe manning document for *Finnøyglimt*, the shipping company clarified its interpretation of the term 'daytime arrangement'. The shipping company believed it was sufficient to have a captain, motorman and able seaman on board if the vessel's voyages did not exceed eight hours. If the vessel was to sail for a longer period, there would have to be a chief mate on board as well. It was thus the voyage and its duration that decided the minimum safe manning. In other words, duties relating to preparing the vessel for the voyage were not considered in the shipping company's assessment of whether a chief mate could be omitted.

Prior to the accident, *Finnøyglimt* had carried a cargo from Tau to Talgje. The vessel arrived at Talgje at 01:50 and moored there for the night. This allowed the crew to rest for five hours until 07:00, when the cargo was to be unloaded. *Finnøyglimt* departed Talgje at 12:45 and arrived Helle at 14:30. The loading started immediately and lasted approximately one hour.

The actual voyage from Helle to Fitjar was scheduled to take 11–12 hours. *Finnøyglimt* departed Helle at 15:55, with the captain, engineer and seaman on board. They expected to arrive at the unloading place in Fitjar around three or four the next morning. Since the duration of the voyage exceeded eight hours, *Finnøyglimt* was supposed to also have a chief mate on board according to the shipping company's understanding of the rules.

If the hours worked include loading, unloading and preparations for the voyage, the crew on *Finnøyglimt* had worked for approximately 20 hours following a five-hour rest period on the day the accident occurred. In the AIBN's view, this constitutes a breach of Section 4 of the Regulations concerning hours of work and rest on board Norwegian passenger and cargo ships etc., and means that *Finnøyglimt*, according to the NMA's interpretation of the term 'daytime arrangement', should have had a chief mate on board.

In the AIBN's view, the manning of the vessel was not sufficient in relation to meeting the provisions of Appendix A part 3-1 Sections 13,14 and 15 to the Regulations concerning watchkeeping on passenger ships and cargo ships. Both the engineer and the able seaman retired to bed in the evening, leaving the captain alone on the bridge during the night.

According to the Watchkeeping Regulations, a proper lookout shall be kept at all times, among other things in order to be able to maintain a permanent state of vigilance by the use of sight, hearing and other available means, with regard to any significant change in the operating environment. The lookout must be capable of devoting his full attention to the task of keeping a proper lookout, and shall not carry out or be assigned any other duties that could interfere with this task.

The need for watchkeeping is further reinforced when the vessel is carrying cargo that requires extra monitoring. For example, the IMSBC code recommends that the cargo holds and the cargo be checked regularly during the voyage if the cargo has the property that it can 'liquefy' at a given moisture content. This is not something the captain can attend to when he is alone on the watch. In the AIBN's opinion, although the crew on *Finnøyglimt* were probably not aware of this property in the sand cargo, the chances of discovering the problem of water leakage and subsequent listing at an earlier stage would have increased had there been a chief mate/lookout on board.

2.4.2 Administrative practice as regards the regulations relating to minimum safe manning

The AIBN cannot say for certain that the size of the crew was decisive in relation to the foundering of *Finnøyglimt*. Regardless of this, the AIBN is of the view that the industry should be able to comply with the content of regulations and the NMA's administrative practice in a uniform manner. In the minimum safe manning document for *Finnøyglimt*, the NMA accepted that the minimum safe manning be reduced provided that a 'daytime arrangement' was practised, without explaining to the shipping company what this condition entailed. The shipping company, on its part, had attempted to interpret the meaning of the term 'daytime arrangement', without arriving at the same understanding of the terms as the NMA. The AIBN believes that a lack of information from the NMA about how to practise the arrangement may have consequences for safety.

2.4.3 The shipping company's safety management

According to the weather forecast, the crew on *Finnøyglimt* should expect a north-westerly moderate to fresh gale with medium high waves across Sletta on the night of the accident. Sletta is well known for its difficult wave conditions, and the crew were also aware of this. The crew was probably not aware of the fact that the sand cargo had the ability to 'liquefy' if the moisture content increased, and that it was especially important to ensure the vessel's watertight integrity. The Regulations concerning safety measures etc. on passenger ships, cargo ships and lighters Section 10 (1) require hatches to be properly closed and secured when the ship is not in port, regardless of the type of cargo it carries and the prevailing weather and sea conditions.

Section 7 of the Ship Safety and Security Act, which applies to all ships regardless of size, states that the shipping company shall ensure that a safety management system that can be documented and verified is established, implemented and developed in the company's organisation and on the individual ships in order to identify and control the risk and also to ensure compliance with requirements laid down in or pursuant to a statute or in the actual safety management system. The contents, scope and documentation of the safety management system shall be adapted to the needs of the company and its activities. The ISM Regulations, which set out detail requirements of the contents of the safety management system, only apply to ships with a gross tonnage of 500 or more, however.

In the AIBN's view, it is unfortunate that the ISM Regulations do not apply to shipping companies that operate ships the size of *Finnøyglimt*. A lack of specification of the minimum requirements that apply to safety management systems may result in a such systems being inadequate in terms of their content or in a documented management system not being established.

One of the most important differences between the former Act of 9 June 1903 No 7 relating to public control of the seaworthiness of ships (the Seaworthiness Act) and the current Ship Safety and Security Act is that the shipping company is assigned responsibility for <u>ensuring</u> that relevant tasks are carried out and that the captain is obliged to <u>arrange</u> that the tasks are carried out. The idea behind the change is that safety will be better attended to if more responsibility is assigned to the shipping company. In the AIBN's view, this is contingent on a serious onshore organisation having been established that is in control of the activities. The AIBN believes that ownership of the system is a necessary success factor in the establishment of a management system, and in relation to the practical implementation of the system's procedures and routines for each individual employee in the onshore operations and on board each ship.

In the present case, the shipping company had three ships, but only *Finnøybulk* was subject to requirements pursuant to the ISM Regulations. In relation to *Finnøybulk*, the owner had delegated responsibility for implementation and follow-up of the system to Karmøy Skipsconsult Management AS. It was thus Karmøy Skipsconsult Management AS's responsibility to ensure compliance with the regulations for *Finnøybulk*. In that connection, the company had established a safety management system for the operation of *Finnøybulk* that included procedures for securing hatch covers.

Because the operation of *Finnøybulk* had been delegated to a management company, experience gained in the operation of *Finnøybulk* was not transferred to the shipping company's other ships. The shipping company had not prepared any form of safety management system for *Finnøyglimt*, either by itself or with the help of external companies. Thus there were no formal written procedures in place for safe operations, or for securing of the cargo hatches. In the AIBN's view, the crew on board *Finnøyglimt* were, as such, left to their own devices in relation to maintaining safety on board.

2.4.4 Regulations relating to the establishment of a management system

In connection with the investigation of a man overboard accident from the cargo ship *Nysand* in 2008, the AIBN submitted a recommendation to the NMA to prepare specifications for the scope of a safety management system for cargo vessels with a gross tonnage of less than 500. The AIBN believes that the investigation into the foundering of *Finnøyglimt* underlines the need for such specifications.

As a follow-up to the recommendation, the NMA is drafting new regulations relating to safety management systems for shipping companies and ships that are covered by Section 7 of the Ship Safety and Security Act, but not by the ISM Regulations.

2.4.5 Supervision by the authorities relating to the securing of hatches

In connection with the investigation into the foundering of the cargo ship *Langeland* in 2009, the AIBN submitted a recommendation to the NMA to take measures to increase awareness concerning the hazards associated with inadequate securing of hatch covers. The AIBN believes that the investigation of the *Finnøyglimt* accident underlines the need for such awareness-raising.

The NMA has not implemented concrete measures after the *Langeland* accident, but it is considering entering into dialogue with the Norwegian Coast Guard with a view to establishing a scheme for inspection of ships at sea.

2.5 Forward trim

Finnøyglimt was probably exposed to considerable amounts of green sea on deck, which increased the risk of water ingress on the voyage in question. The amount of green sea on deck was particularly high because of the ship's forward trim.

2.5.1 The vessel's design

According to the provisions of the Load Line Convention, *Finnøyglimt* was to have a bow height of at least 2 225 mm[20] when loaded to the summer load line on even keel.

[20] (56 x 43.53 x (1 – 43.53/500)) mm = 2 225 mm

Finnøyglimt's national summer freeboard of 300 mm corresponded to a moulded draught of 3.725 m. The vessel had a bow height at forward perpendicular of 2 785 mm[21], measured from the national summer load line without trim to the forecastle deck. This is more than the minimum requirement of 560 mm[22]. According to the Norwegian Shipbuilding Regulations, the vessel can then have a forward trim of maximum 3% of the excess bow height, i.e. 168 mm[23].

The stability calculations carried out by the AIBN after the accident; see Annex D, show that *Finnøyglimt*, when homogenously loaded to the national summer load line, had a forward trim of 0.916 m in departure condition and 1.239 m in arrival condition, ref. load conditions 6 and 7.

The bow height could have been increased by raising the forecastle deck. According to the Shipbuilding Regulations, however, the maximum forward trim would nonetheless have been limited to 0.5% of the length of the vessel, i.e. 218 mm.[24] In the AIBN's opinion, the underlying cause of *Finnøyglimt's* excessive forward trim was therefore that the cargo hold was placed too far forward.

In addition, the AIBN would like to point out the importance of avoiding a forward trim, especially on vessels without rake of keel, in order to maintain satisfactory manoeuvring properties.

2.5.2 Regulations relating to trim and stability

The provisions on forward trim in the Shipbuilding Regulations of 1979 were upheld in the Shipbuilding Regulations of 1969, but have been left out of shipbuilding regulations adopted after 1979.

In connection with the investigation into the accident involving the cargo ship *Langeland* in 2009, the AIBN submitted a recommendation to the NMA to reintroduce provisions on maximum forward trim/minimum bow height for cargo ships in homogenous load conditions. The AIBN believes that the investigation into the foundering of *Finnøyglimt* underlines the need for such provisions. In that connection the AIBN will, however, emphasize that the recommendation may be followed up by submitting a proposal to the International Maritime Organization (IMO) to modify the International provisions.

2.5.3 Inspection by the authorities of stability documentation

Stability calculations carried out after the *Finnøyglimt* accident found that the calculations that were approved by the NMA on 16 March 1999 were based on an incorrect longitudinal centre of gravity for the cargo, which gave the vessel a bigger aft trim/smaller forward trim than it actually had. The calculations also show that the vessel's stability in homogenous load condition failed to meet applicable stability criteria. As such, *Finnøyglimt's* stability should not have been approved by the NMA in 1999.

In connection with the foundering of *Langeland*, the AIBN submitted a recommendation to the NMA to order cargo ships for which stability calculations have not been carried out

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[21] (6 500 – 4 015 – 300) mm = 2 785 mm
[22] (2 785 – 2 225) mm = 560 mm
[23] (560 x 0.3) mm = 168 mm
[24] (43 530 x 0.005) mm = 218 mm

using an approved program[25] to procure new and complete trim and stability documentation. The AIBN believes that the investigation into the foundering of *Finnøyglimt* supports this recommendation. The calculations that were approved in 1999 were carried out manually. Today's requirements for the performance and presentation of stability calculations make it easier to identify and correct any errors.

In response to the question of how the recommendation has been followed up, the AIBN was told that the NMA considers it inexpedient to instruct existing ships to carry out new stability calculations if the ships have not been altered. In order to fulfil the intention of the recommendation, the NMA has prepared a safety notice that will be distributed to corresponding ships.

2.6 Knowledge about the sand's properties

Finnøyglimt probably started to list because the sand shifted. The AIBN's investigation has found that the sand that was shipped from the NCC's facility had the property that it would liquefy when the moisture content reached 11.5% of the dry weight.

2.6.1 <u>The shipper's role</u>

According to the shipper, no investigations were carried out to determine the sand and the aggregate's angles of repose, or their ability to 'liquefy'. Nor had any measurements been carried out of the sand and the aggregate's moisture content prior to loading. The shipper's management system did not include procedures for determining the properties or measuring the moisture content of the cargo. This means that the shipper did not focus on keeping the sand's moisture content at a minimum level in connection with storage. On the contrary, the management system contained instructions on watering/spraying the sand to avoid dust emissions. Thus, the shipper had no knowledge of the sand's ability to 'liquefy' if the moisture content exceeded a certain limit.

Since the shipper was not aware of the cargo's properties, the crew on board *Finnøyglimt* were not given sufficient information either, as required by the Regulations concerning the carriage of cargoes on cargo ships and barges.

The AIBN is of the opinion that, in future, ships being loaded at NCC's facilities must be given information about, among other things, the sand's ability to 'liquefy', as well as information about the transportable moisture limit (TML). Furthermore, the ship's crew must ensure that special precautions are taken, among other things in relation to the securing of hatch covers.

2.6.2 <u>The shipping agent's role</u>

The shipping agent Karmøy Grus & Pukk brokered the assignment between the shipper NCC Roads AS and the shipping company Ryfylke Shipping AS. According to the AIBN's understanding of the regulations, the shipping agent has no formal role in connection with the communication of information about the cargo's properties.

[25] Computer program approved by the NMA.

2.6.3 The role of the supervisory authority

The former BC Code and the new IMSBC Code classify bulk cargoes according to the hazard potential associated with bulk shipments. The BC Code contains no information about the fact that sand may have the property that it can 'liquefy' during shipping if the sand cargo becomes moist. According to the IMSBC Code, however, which replaced the BC Code in 2013, heavy mineral sand may have this property. In the AIBN's investigation into the foundering of *Finnøyglimt*, it was also found that other types of sand can have this property.

Regulations of 29 June 2006 No 785 concerning the carriage of cargoes on cargo ships and barges refer to the provisions of the BC Code. The NMA has now distributed a draft revision of the regulations for consultation in which the reference to the BC Code has been replaced by a reference to the IMSBC Code. Both sets of regulations contain the provisions that the shipper shall conduct investigations to determine the cargo's properties and inform the ship's crew in connection with loading.

The AIBN's investigation has found that NCC was not aware of these provisions, and it is assumed that other shippers may also have insufficient knowledge of these provisions. The AIBN is of the opinion that the scope of the problem must be determined, and that relevant measures must be implemented to ensure that the provisions of the currently applicable Cargo Carriage Regulations are known and complied with.

3. CONCLUSION

The AIBN sums up its investigation of the *Finnøyglimt* accident on 7 October 2011 by drawing the following conclusions:

3.1 Chain of events and immediate causes of the accident

- The vessel's forward trim resulted in a particularly large amount of green sea.
- The AIBN believes that there was gradual water ingress to the vessel's cargo hold as a result of green sea on deck
- The water probably entered the cargo hold through leaking hatches.
- The AIBN believes that the sand cargo in the aft part of the cargo hold shifted to the port side as a result of an increase in its moisture content.

3.2 Contributory causes

- *Finnøyglimt's* design gave the vessel a forward trim in homogenous load condition. In the AIBN's view, the forward cargo hold bulkhead was placed too far forward.
- The shipping company had not established a safety management system for the operation of *Finnøyglimt*. This meant that no written procedures existed for securing the hatch covers. The crew's normal practice was to secure the hatches on the captain's orders, and always during winter. Inadequate securing of the cargo hatch covers meant that the hatches were not watertight.
- The AIBN cannot rule out that the manning of the vessel had an impact on the preparations for *Finnøyglimt's* voyage, including in relation to securing the vessel's watertight integrity before departure.
- According to the minimum safe manning document issued by the NMA, in addition to the captain, *Finnøyglimt* should be manned with a chief mate, an engineer and an able seaman with the ability to cook. The NMA accepted a reduction of the minimum safe manning, however, without stating the conditions for doing so.
- The shipper had not investigated the properties of the sand in question and was therefore not aware of the cargo's properties. The shipper therefore had no basis for providing the crew of *Finnøyglimt* with correct information, as required by regulations.
- The crew's inadequate knowledge about the sand's properties meant that relevant precautions were not taken to prevent the cargo from shifting.

3.3 Measures to prevent similar accidents

- In the AIBN's view, the investigation into the foundering of *Finnøyglimt* demonstrates a need for increased awareness about the hazards associated with inadequate securing of hatch covers. In that connection, the AIBN would like to refer to safety recommendation MARINE No 2012/07T, which was submitted to the NMA after the investigation into the foundering of the cargo ship *Langeland* on 31 July 2009.

- In the AIBN's view, the investigation into the foundering of *Finnøyglimt* demonstrates a need for provisions on maximum forward trim / minimum bow height for cargo ships in homogenous load condition. In that connection, the AIBN would like to refer to safety recommendation MARINE No 2012/07T, which was submitted to the NMA in connection with the investigation into the foundering of the cargo ship *Langeland* on 31 July 2009. In that connection the AIBN will, however, emphasize that the recommendation may be followed up by submitting a proposal to the International Maritime Organization (IMO) to modify the International provisions.

- In the AIBN's view, the investigation into the foundering of *Finnøyglimt* demonstrates a need for a formal specification of the content of safety management systems for cargo ships with a gross tonnage of less than 500. In that connection, the AIBN would like to refer to safety recommendation MARINE No 2010/07T, which was submitted to the NMA after a man overboard accident involving the cargo ship *Nysand* on 24 October 2008.

- The NMA had initially set a minimum safe manning for *Finnøyglimt* of four crew members, but, according to the minimum safe manning document, the crew could be reduced to three when a 'daytime arrangement' was practised. The term 'daytime arrangement' had not been defined in the minimum safe manning document or in the regulations, however, and the shipping company had a different understanding of the term from the NMA. Despite that fact that it cannot be ascertained that the manning of the vessel was decisive in relation to *Finnøyglimt's* foundering, the AIBN believes that the term 'daytime arrangement', which is used in the minimum safe manning document, should be clarified. A safety recommendation is submitted to the NMA in this connection.

- The AIBN is of the view that NCC should look into the properties of the products being shipped from its facilities and comply with the provisions of the Norwegian Cargo Carriage Regulations as amended from time to time as regards providing information to ships that load such products. A safety recommendation is submitted to NCC in this connection.

- The AIBN does not know the scope of the problem, but it assumes that other shippers may also be unaware of the provisions in the Regulations concerning the carriage of cargoes on cargo ships and barges on investigating and providing information about the properties of the cargo. The AIBN is of the opinion that the scope of the problem must be determined, and that relevant measures must be implemented to ensure that the provisions of the currently applicable Cargo Carriage Regulations are known and complied with. A safety recommendation is submitted to the NMA in this connection.

4. SAFETY RECOMMENDATIONS

The investigation of this marine accident has identified three areas in which the AIBN deems it necessary to submit safety recommendations for the purpose of improving safety at sea.[26]

Safety Recommendation MARINE No 2014/17T

The AIBN's investigation into the foundering of the cargo ship *Finnøyglimt* on 7 October 2011 has shown that sand (0–8 mm) shipped from the NCC Roads AS's facility in Helle has the property that it may 'liquefy' when the moisture content exceeds a certain limit. This can cause cargo that is being shipped from the facility to shift during transport if adequate precautions are not taken.

The Accident Investigation Board Norway recommends that NCC Roads AS look into the properties of the products being shipped from its facilities and ensure compliance with the provisions of the regulations concerning the carriage of cargo in bulk, as applicable from time to time, by providing information to ships that load such products.

Safety Recommendation MARINE No 2014/18T

The AIBN's investigation of the accident involving the cargo ship *Finnøyglimt* on 7 October 2011 has shown that the shipper had not looked into the properties of the sand or informed the ship about the risk of the cargo 'liquefying' at a given moisture level. The AIBN assumes that other shippers may also be unaware of the provisions in the applicable Regulations on the carriage of cargoes on cargo ships and barges with regard to determining and providing information about the properties of the cargo. The consequences may be that the ships' crew fail to take necessary precautions in relation to the cargo.

The Accident Investigation Board Norway recommends that the Norwegian Maritime Authority look into the scope of the problem and implement relevant measures to ensure that the provisions of the currently applicable Regulations concerning the carriage of cargoes on cargo ships and barges are complied with.

Safety Recommendation MARINE No 2014/19T

The AIBN's investigation into the foundering of the cargo ship *Finnøyglimt* on 7 October 2011 has shown that the NMA, when issuing minimum safe manning documents, uses the term 'daytime arrangement' to describe circumstances in which the shipping company is allowed to reduce the number of crew. Since the term 'daytime arrangement' has not been formally defined, it can result in the shipping company reducing the number of crew on an incorrect basis.

The Accident Investigation Board Norway recommends that the Norwegian Maritime Authority consider its practice relating to the stipulation of minimum safe manning pursuant to the Regulations of 18 June 2009 No 666 concerning the manning of Norwegian ships, and Regulations of 27 April 1999 No 537 concerning watchkeeping on passenger ships and cargo ships, by clarifying the term 'daytime arrangement'.

Accident Investigation Board Norway
Lillestrøm, 22 September 2014

[26] The investigation report is submitted to the Ministry of Trade, Industry and Fisheries, which will take necessary action to ensure that due consideration is given to the safety recommendations.

APPENDICES (B-F IN NORWEGIAN)

Annex A: Relevant abbreviations

Annex B: Weather observations and description of the waters (Vedlegg B: Værobservasjoner og farvannsbeskrivelse)

Annex C: The vessel's movements along the fairlead (Vedlegg C: Fartøyets bevegelser i farvannet)

Annex D: The properties of the cargo (Vedlegg D: Lastens egenskaper)

Annex E: Stability calculations (Vedlegg E: Stabilitetsberegninger)

Annex F: NCC's procedure for document handling when loading ships, and procedure for loading ship cargoes (Vedlegg F: NCC's prosedyre for dokumenthåndtering ved skipslasting og prosedyre for lasting av skipslaster)

ANNEX A: RELEVANT ABBREVIATIONS

AIBN	:	Accident Investigation Board Norway
BHP	:	Brake horsepower
COG	:	Course Over Ground
CRA	:	Certificate of Receipt of Application
FMP	:	Flow Moisture Point
GL	:	Germanischer Lloyd
GM	:	Metacentric height
GZ curve	:	Righting lever curve
IMO	:	International Maritime Organisation
ISM	:	International Safety Management
JRCC	:	Joint Rescue Coordination Centre
KW	:	Kilowatt
MSC	:	Maritime Safety Committee
NCA	:	Norwegian Coastal Administration
NOR	:	Norwegian Ordinary Ship Register
NMA	:	Norwegian Maritime Authority
NMA	:	Norwegian Mapping Authority
ROV	:	Remotely Operated Vehicle
SOLAS	:	Safety of Life at Sea
The BC Code	:	Code of Safe Practice for Solid Bulk Cargoes
The CSS Code	:	Code of Safe Practice for Cargo Stowage and Securing
The IMDG Code	:	International Maritime Dangerous Goods Code
The IMSBC Code	:	International Maritime Solid Bulk Cargoes Code
TML	:	Transportable Moisture Limit
VTS	:	Vessel Traffic Service
WEHS	:	Working environment, health and safety

VEDLEGG B: VÆROBSERVASJONER OG FARVANNSBESKRIVELSE

1. INNLEDNING OM VÆROBSERVASJONER OG FARVANNSBESKRIVELSE

På ulykkestidspunktet var det stiv kuling fra nordvest og høy sjø.

Den høye sjøen bestod hovedsakelig av vindsjø fra nordvest med bølgehøyder omkring 4,5 meter, dominerende bølgeretning var fra nordvest, dvs. 330 grader, dominerende bølgeperiode på 12 sekunder og dominerende bølgelengde over dypt vann omkring 225 meter. Disse bølgene ville begynne å bli påvirket av bunnforholdene og ville dermed kunne bli stuvet sammen og endre retning der dybdene er omkring 112 meter eller grunnere. Enkeltbølger (unntaksvis) kan ha vært opptil 6,75 til 9 meter.

Det var også dønninger fra vest med bølgehøyder omkring 2 meter, bølgeperiode på 14-15 sekunder og bølgelengder omkring 306 - 351 meter. Disse bølgene ville begynne å bli påvirket av bunnforholdene og ville dermed kunne bli stuvet sammen og endre retning der dybdene er omkring 150-175 meter eller grunnere.

Modellberegningene om bølgeforhold utført av Meteorologisk institutt forutsetter åpent hav og tar ikke hensyn til lokale forhold nærme kysten. Det har derfor vært nødvendig å vurdere bølgeforholdene opp mot

1. hvordan de kystnære forhold og bunnforholdene (topografien) kan ha påvirket vindsjøen i de områdene fartøyet seilte

2. hvordan bunnforholdene kan ha påvirket dønningene i de områdene fartøyet seilte

Da det knyttes større usikkerhet til de faktiske strømforholdene vil dette ikke vektlegges under analysen.

Topografien av havbunnen og land påvirker bølger. Hvordan bølgene endres avhenger av en rekke forhold. Uten å være utfyllende på dette vil Havarikommisjonen kun liste kort opp noen av forholdene som kan være relevant i forbindelse med denne ulykken[1].

- Bølgene kan stues sammen når de beveger seg fra dypt vann til endelig vann. Med stuving menes at bølgene endrer form ved å bli kortere (kortere bølgelengde) og høyere. Dypt vann defineres der dybden er større enn halvparten av bølgelengden. Endelig vann defineres der dybden er lik eller mindre enn halvparten av bølgelengden. Det vil si at definisjonene om dypt og endelig vann er basert på dybden i relasjon til bølgelengden.

- Ved sakte varierende dybdeforhold vil det kunne oppstå bølgerefraksjon (også kalt dybderefraksjon og bunnrefraksjon) og diffraksjon. Med sakte endring av bunnivået menes at dybden forandrer seg lite sammenlignet med bølgelengden.

[1] Kompendium Oceanography TMR4230. Dag Myrhaug, januar 2006, Institutt for marin hydrodynamikk, NTNU.

Ettersom vanndybden endres vil bølgene kunne endre retning, samt lengden på bølgene og høyden.

- Ved brå endring av bunnivået, slik som sterkt skrånende bunn, vil det kunne oppstå både reflekterte og transmitterte bølger.

- Under vekselvirkning mellom bunntopografi og bølger vil bølgenes periode forbli konstant.

Det kan også oppstå vekselvirkninger mellom bølger og strøm. Ved at bølger og strøm går i samme retning, vil bølgelengden øke og bølgehøyden avta. Når strømmen går mot bølgene, vil bølgelengden avta og bølgehøyden øke. Dette kan skape farlige bølger for mindre fartøy. Bølgenes retning kan også bli endret som følge av vekselvirkning mellom bølger og strøm.

2. VÆRMELDING, VÆROBSERVASJONER OG MODELLBEREGNINGER OMKRING ULYKKESTIDSPUNKTET

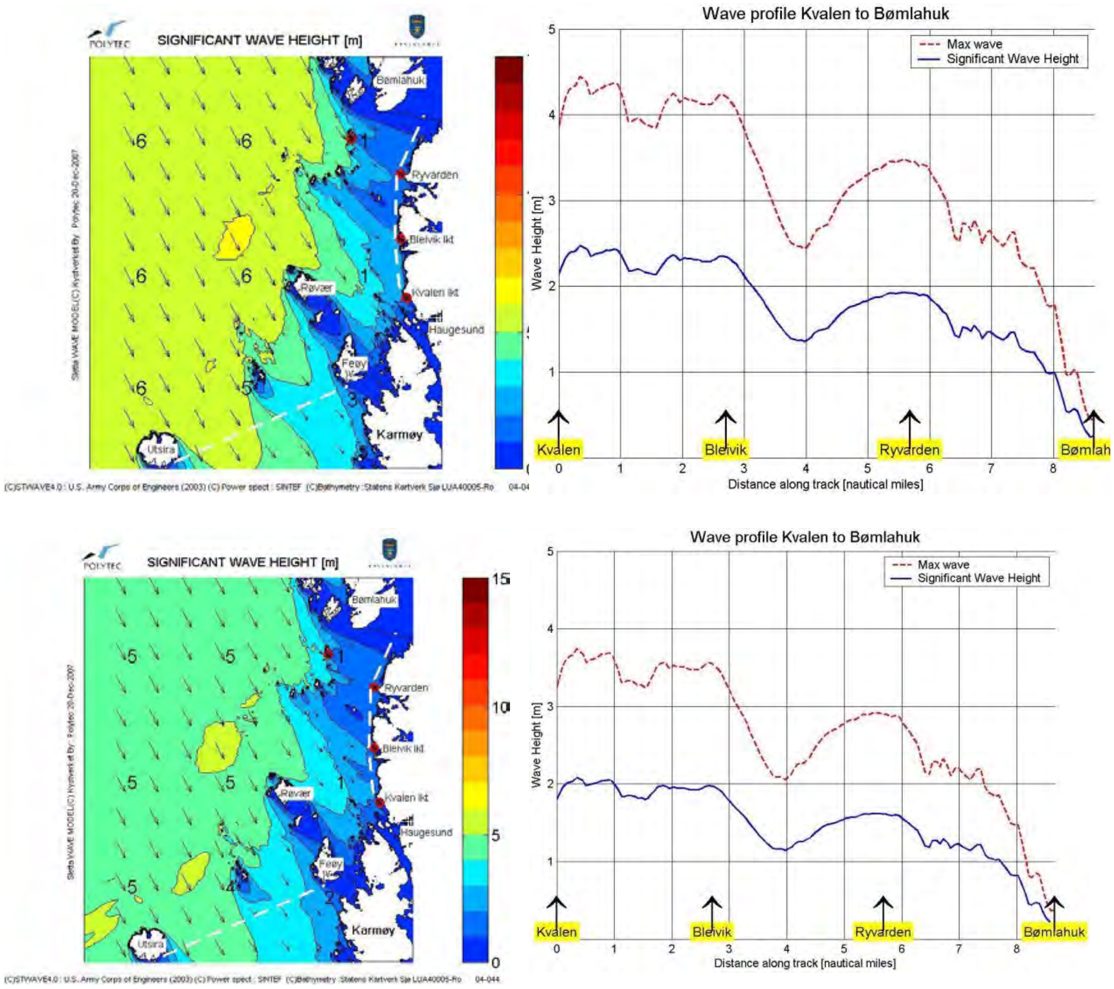
2.1 Værmelding

2.1.1 Værmelding for det aktuelle tidsrommet

Fredag 7. oktober 2011 kl. 15 ble følgende værvarsel for kystområdet Karmøy - Fedje gitt av Meteorologisk institutt. Værvarselet gjaldt til lørdag kl. 24:

«Karmøy - Fedje:
Nordvest sterk kuling 20, fra i natt stiv kuling 15. Regnbyger. Fra lørdag morgen nordvest frisk bris 10. Enkelte regnbyger. Fra lørdag formiddag nordlig frisk bris 10. Etter hvert oppholdsvær. Om kvelden skiftende bris. Stort sett pent vær.»

Meteorologisk institutt ga også spesialvarsler om bølgeforhold ved for Sletta som vist i figur 1. Dette spesialvarselet var tilgjengelig på internett. Figuren viser at i området mellom Bleivik og Ryvarden var det varslet signifikant bølgehøyde på mindre enn 2 meter og maksimal enkeltbølge mindre enn 3,5 meter.



Figur 1: Kart og grafer som viser bølgehøyden i det aktuelle området for henholdsvis kl. 22 og kl. 24 ulykkesdagen. Kilde: Meteorologisk institutt, se http://spesial.met.no/refraction/sletta/sletta_ged.shtml.

2.2 Værobservasjoner for Sletta og modellberegninger omkring ulykkestidspunktet

I følge opplysninger fra Solfjord var det 3 – 5 m høye bølger i området i tidsrommet ved forliset. Vinden ble målt til 20 m/s fra nordvest.

Observasjoner ved Røvær målestasjon viser at middelvinden i denne perioden var 16 m/s med kraftigste vindkast på 22 m/s. Noe tidligere på kvelden ble middelvind og kraftigste vindkast målt til henholdsvis 19 m/s og 24 m/s.

Modellberegninger utført av Meteorologisk institutt etter ulykken, viser at det for havområdet like utenfor Sletta var det signifikant bølgehøyde[2] omkring 4.5 m. Dette tilsvarer høy sjø.

[2] Signifikant bølgehøyde, dvs. gjennomsnittsverdien av den høyeste tredjedelen av individuelle bølgehøyder i en 20-minuetters periode. Enkeltbølger kan være 1,5 og opptil til 2 ganger høyere enn signifikant bølgehøyde. Kilde: http://metlex.met.no/wiki/Signifikant_bølgehøyde

Den dominerende bølgeperioden var ca. 12 s og dominerende retning fra nordvest (ca. 330 grader).

Det var vindsjø fra nordvest som ga det største bidraget til bølgene, men det var også dønning fra vest (ca. 270 grader) med høyde ca. 2 m og periode 14-15 s. Modellberegningene tar ikke hensyn til de lokale variasjonene nærme kysten.

Modellberegningene er representative for bølgeforholdene i havområdene som ikke er beskyttet av landmasser eller ved større dybdevariasjoner. Modellen har derfor ikke tatt hensyn til de lokale variasjonene i bølgeforholdene nær kysten.

Meteorologisk institutt hadde ingen noen gode data om strømforholdene i området.

2.3 Tidevannsstrøm

Kartverket måler vannstand og gir informasjon om tidevann gjennom nettsiden, se Havniva.no.

Basert på opplysningene nedenfor var det høyvann ved Sletta en gang mellom kl. 20:04 og 20:51 (lokal tid). De målte forskjellene var mindre enn midlere tidevannsforskjell ved spring[3].

Den norske los opplyser om at det vil oppstå størst tidestrømhastighet ved høy- og lavvann[4]. Ytterst ved kysten i området Sletta – Selbjørnsfjorden går tidevannsstrømmene nordover ved høyvann og sørover ved lavvann. I Bømlafjorden går tidevannsstrømmen innover på stigende sjø og utover på fallende sjø. Sterk vind kan føre til store endringer i strømningsmønsteret[5].

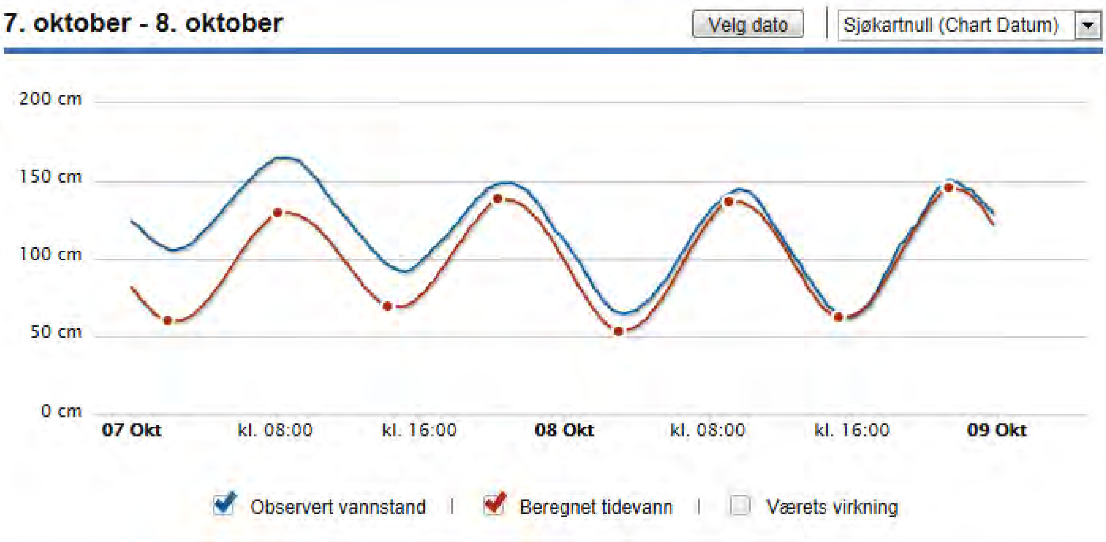
Det at det var stiv kuling på ulykkestidspunktet medfører derfor at det knytter seg usikkerhet til strømforholdene fra tidevann på ulykkestidspunktet. Derfor knytter det seg større usikkerheter til tidevannsstrømmens betydning på bølgeforholdene omkring ulykkestidspunktet.

For Bergen ble det opplyst følgende om tidevann:

[3] Ref. Den norske los, bind 3, 6. utgave 2006 p33

[4] På Vestlandet, utenfor kysten og åpne kyststrekninger, vil det bli størst strømhastighet nordover ved høyvann. Dette gjelder ikke ved fjordmunningene. Der vil det være strømstille ved høy- og lavvann og maksimal strøm mellom høy- og lavvann. Der vil strømmen gå inn fjorden ved stigende og ut fjorden ved fallene vannstand. Nær land og i sund og fjorder kan strømmen bare løpe i to motsatte retninger, parallelt med land. Den norske los, bind 1, 7. utgave (2004) p185.

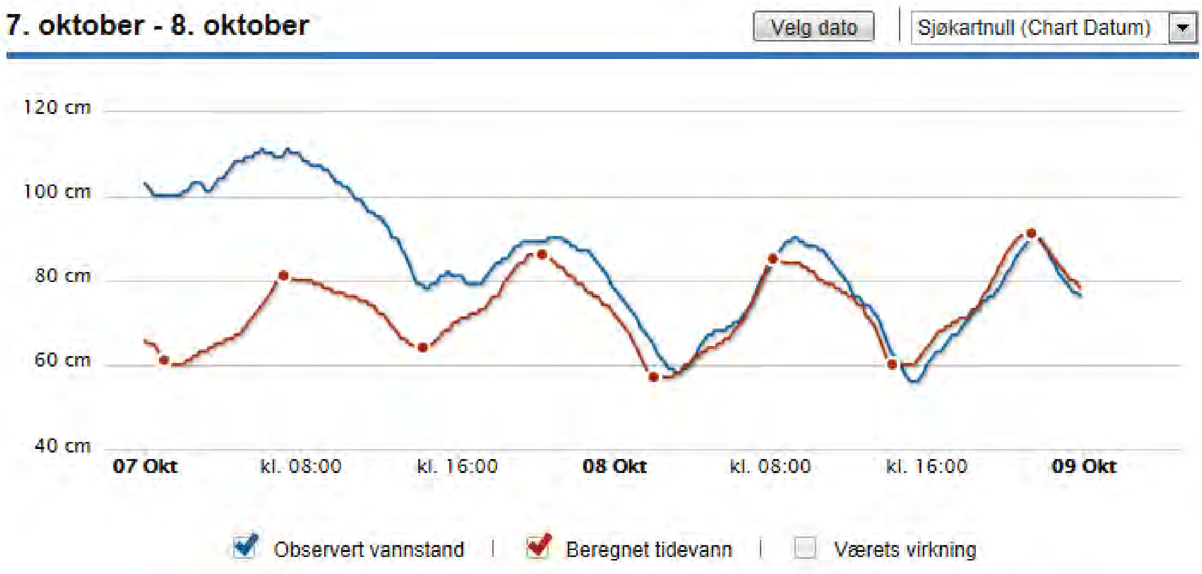
[5] Den norske los, bind 3,7. utgave 2012 p177.



7. oktober 2011, fredag

Høy/lav	Tid	Beregnet tidevann
	kl. 02:26	60 cm
	kl. 08:41	129 cm
	kl. 14:44	69 cm
	kl. 20:51	138 cm

For Stavanger ble det opplyst om følgende:



7. oktober 2011, fredag

Høy/lav	Tid	Beregnet tidevann
	kl. 01:42	61 cm
	kl. 07:46	81 cm
	kl. 14:03	64 cm
	kl. 20:04	86 cm

3. FARVANNSBESKRIVELSE

3.1 Meteorologisk institutt har opplyst følgende:

«Sletta er noe skjermet for sjø fra nordvest, spesielt så langt nord som det antatte forlisstedet. Skjermingen er litt mindre lenger sør på Sletta. Dønningen fra vest kommer relativt uhindret inn midt på Sletta, men det er noen holmer og grunner som bør dempe dønningene når en kommer så langt nord som 59° 30,5', men ved spesielle bunnforhold er det og mulig at dønningene kan skifte retning.»

3.2 Den norske los, Bind 1 - Farlige bølger ved Sletta

I navigasjonskartet fra Statens Kartverk står det påskrevet advarsel ved Sletta som lyder følgende: Aktsomhetsområde. Se 'Dnl', bind 1 «Farlige områder».

I Den norske los, Bind 1[6], står det om Sletta følgende. Posisjonen er oppgit til 59°29'N 05°10'E:

«Sletta er et åpent havstykke NW av Haugesund. Dybdene varierer meget, fra grunner med et par meters dybde og ned til ca 250 m. Området er relativt snevert, og de store dybdevariasjonene er årsak til svært rotete og krapp sjø når bølger kommer inn fra SW til NW. Forholdene blir enda verre med tidevannsstrøm i motsatt retning av bølgene.»

3.3 Oceanografi

3.3.1 Fralandsvind – Bølgevekst begrenset av avstanden til land som følge av fralandsvind

Tabell IX/3 i Den norske los Bind 1 angir vindstyrke og bølgehøyde og betingelsene for minste distanse vinden må virke over samt minste varighet for å oppnå varighet.

3.3.2 Vekselvirkninger mellom bølger og strøm

Den norske los, bind 1, opplyser om følgende forhold om vekselvirkninger mellom bølger og strøm:

[6] Område 17, Kapittel IX, Statens kartverk sjø, 8. utgave, 2010.

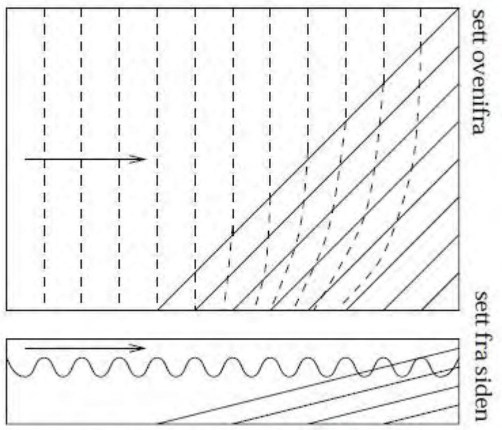
- Når bølger og strøm går i samme retning, vil bølgelengden øke og bølgehøyden avta.

- Når strømmen går mot bølgene, vil bølgelengden avta og bølgehøyden øke. Dette kan skape farlige bølger for mindre fartøy.

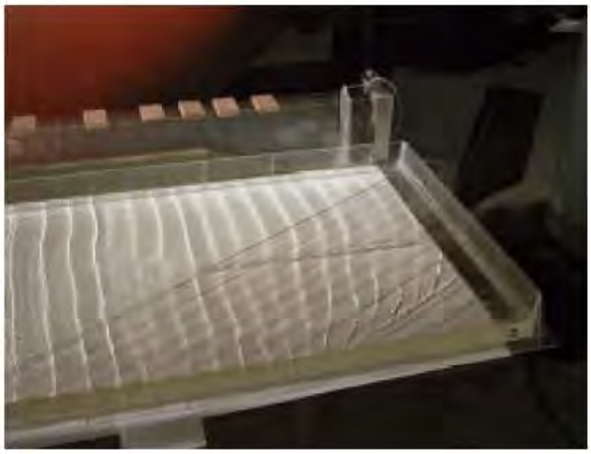
- Bølgenes retning kan endres som følge vekselvirkning mellom bølger og strøm. Det kan oppstå strømrefraksjon samt fokusering ved at bølgehøyden øker betydelig.

3.3.3 Vekselvirkning bølger og topografi, bølgerefraksjon og diffraksjon

Følgende illustrerer dreining av bølgekammer som brer seg mpt en skrå strand[7]:



Dreining av bølgekammer for bølger som brer seg mot en skrå strand. De stiplede linjene er bølgekammer, og de heltrukne er dybdekurver, i øverste del av figuren.



Den norske los, bind 1, opplyser om vekselvirkning mellom bølger og land som følger:

Når bølgene kommer inn på en dybde som tilsvarer den halve bølgelengden begynner de å endre form. Bølgelengden vil bli kortere og bølgehøyden større. Dermed blir bølgene brattere (krappe, steilere). En bølge vil bryte når forholdet H/d ≈ 0,8, se figur[8]. Bunnens helning og bølgenes steilhet bestemmer hva slags brytning som forekommer.

[7] 81524 Hydrodynamikk og havmiljø GK, Laboratoriedemonstrasjon, Lader og Rognebakke 1997.
[8] Den norske los, Bind 1, p197

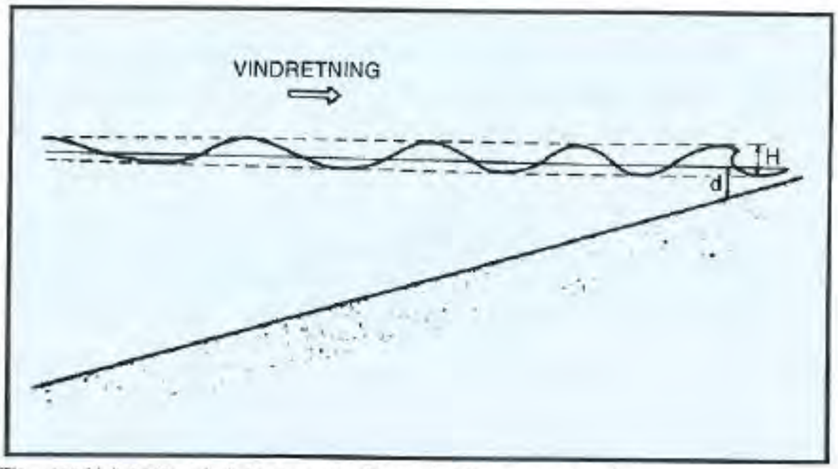


Fig IX/13 Vekselvirkning mellom bølger og land. Bølgekammene er parallelle med kysten. Bølgene bryter når forholdet H/d blir omtrent lik 0,8

Bølgerefraksjon og bølgediffraksjon

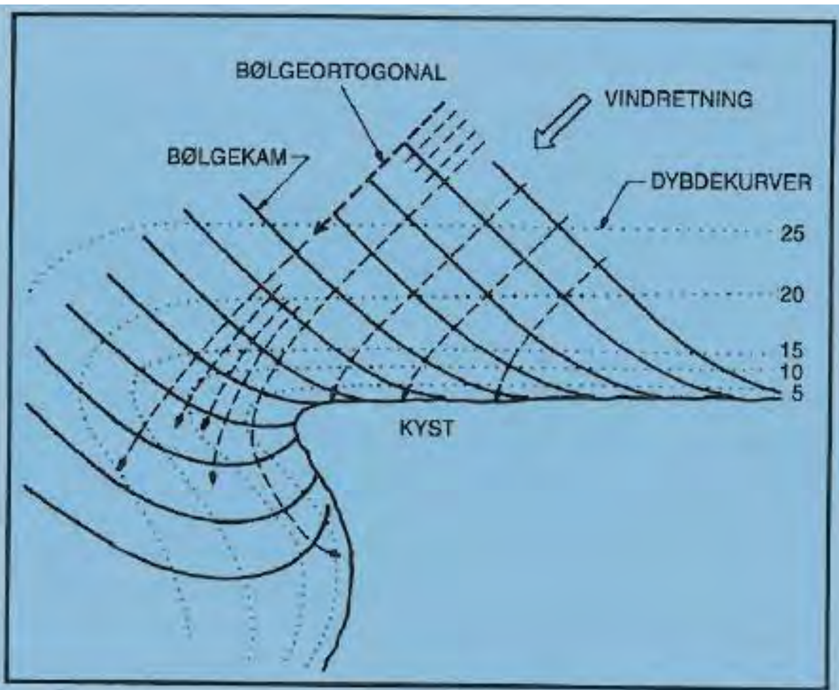


Fig IX/14 Eksempler på topografisk bølgerefraksjon og diffraksjon ved en kyst

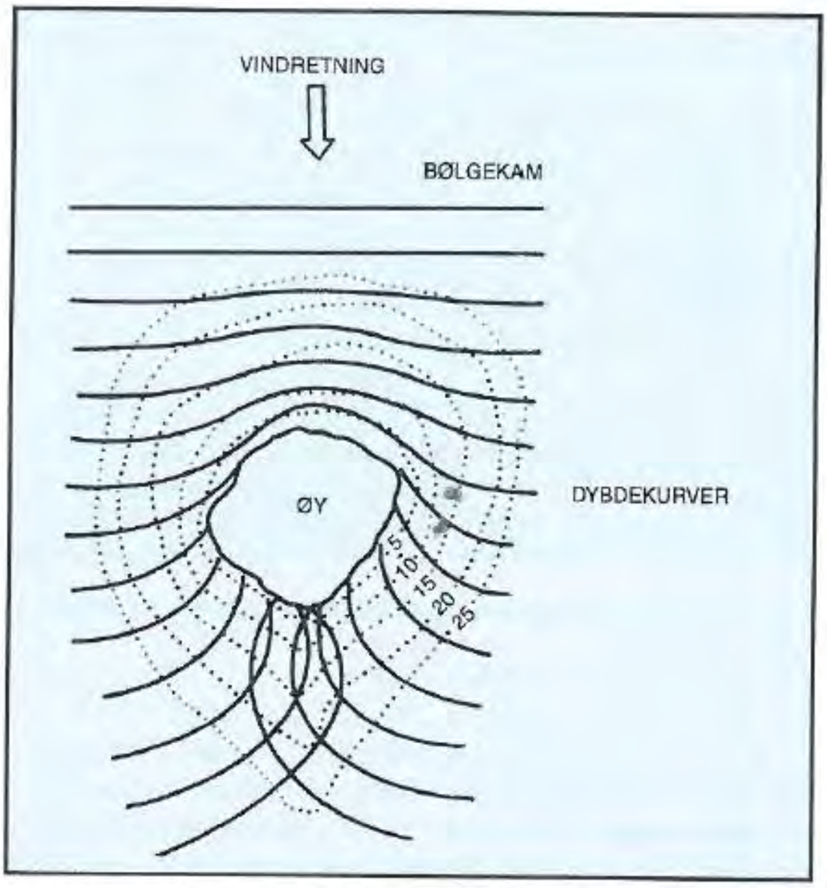


Fig IX/15 Eksempel på bølgerefraksjon og diffraksjon ved øy. På lesiden av øya øker bølgehøydene vesentlig

Ved brå endring av bunnivået vil det kunne oppstå både reflekterte og transmitterte bølger. Bølgerefleksjon oppstår ved en spesiell bratt endring av vanndybden. F.eks. ved et fjell som vist på figuren. I slike tilfeller vil bølgene slå inn mot fjellet og reflekteres tilbake. Dette kan forårsake stående bølger der den total bølgehøyden blir omtrent dobbelt så store som de opprinnelige. Bølgerefleksjon forutsetter en topografi med en brå endring av bunnforholdene rett ved fjellsiden.

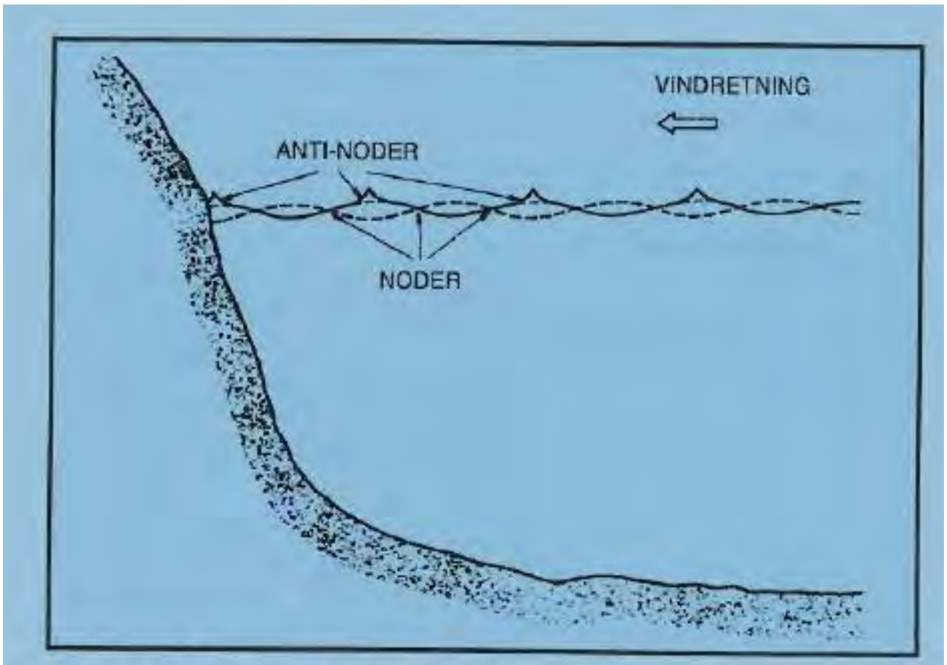


Fig IX/16 Bølgerefleksjon gir stående bølger foran et bratt fjell

I følge wikipedia.no defineres interferens som følgende:

«**Interferens** er fenomenet at svingninger på et punkt i et bølgende medium er lik summen av svingningene til alle bølgene som går gjennom punktet. Hvis for eksempel to bølger med samme amplitude møtes med samme fase i et punkt, vil svingningen i punktet bli summen, altså det dobbelte av hver enkelt. Dette kalles *konstruktiv interferens*. Hvis de derimot møttes i motfase, vil de oppheve hverandre, noe som kalles *destruktiv interferens*.»

3.3.4 Forenklede beregningsformler for bølger

Basert på en forenklet teori antas forholdet mellom bølgeperiode, T og bølgelengde, λ slik for dypt vann. Med dypt vann menes at bølgelengden er større enn to ganger dybden:

$$\lambda = \frac{gT^2}{2\pi}$$

, der g er tyngdeakslerasjonen = 9,81 m/s²

Dønningenes bølgehastighet, C_ω kan utledes fra forholdet mellom bølgelengde og bølgeperiode:

$C_\omega = \lambda/T = gT/2\pi$.

Fra modellberegningene fremgår det at det var vindsjø fra nordvest som ga det største bidraget til bølgene. I tillegg var det et bidrag fra dønninger, det vil si bølger som har blitt generert tidligere et annet sted.

Disse beregningene forutsetter åpent hav og tar ikke hensyn til lokale forhold nærme kysten.

3.4 Beregnede og antatte sjøforhold i området

3.4.1 Vindsjø - dominerende bølger:

3.4.1.1 *Vindsjø over dypt vann:*

Følgende er beregninger som er representative for åpent havområde over dypt vann vest for Sletta.

Med signifikant bølgehøyde på 4,5 m kan enkeltbølgene ha vært opptil 6,75 til 9 meter.

Med dominerende bølgeperiode på 12 sekunder antas det at den dominerende bølgelengden på dypt vann var omkring 225 meter.

Dominerende bølgeretning var fra nordvest, dvs. 330 grader.

Disse bølgene vil begynne å påvirkes av bunnforholdene og dermed kan stuves sammen og endre retning der dybdene er omkring 112 meter eller grunnere.

Bølgehastigheten for de dominerende bølgende antas å ha vært omkring 19 m/s, tilsvarende 36 knop.

3.4.1.2 *Vekselvirkning vindsjø og tidevannsstrøm*

Det knyttes større usikkerhet til strømforholdene fra tidevann for området. Forutsatt normale forutsetninger, dvs. at det på Sletta var en relativt høy tidevannsstrøm nordover langs land, kan vekselvirkningen mellom tidevannsstrømmen og vindbølgene forårsaket at bølgene ble høyere og krappere (bølgelengden avtar, bølgehøyden øker). Men da det knyttes større usikkerhet til de faktiske strømforholdene vil dette ikke vektlegges under analysen.

3.4.2 Dønninger fra vest:

3.4.2.1 *Dønninger over dypt vann:*

Følgende er beregninger som er representative for åpent havområde over dypt vann vest for Sletta.

Høyden på dønningene var omkring 2 m.

Dønninger med bølgeperiode på 14-15 sekunder antas hadde bølgelengder omkring 306 - 351 meter.

Dominerende bølgeretning var fra vest, dvs. 270 grader.

Disse bølgene vil begynne å påvirkes av bunnforholdene og dermed kan stuves sammen og endre retning der dybdene er omkring 150-175 meter eller grunnere.

Dønningenes bølgehastighet (fasehastigheten), C_{ω}, antas å ha vært omkring 22 m/s, tilsvarende 46 knop.

3.4.2.2 *Dønninger og tidevannsstrøm*

Det knyttes større usikkerhet til strømforholdene fra tidevann for området. Forutsatt normale forutsetninger, dvs. at det på Sletta var en relativt høy tidevannsstrøm nordover langs land, vurderes det at vekselvirkningen mellom strøm og dønningene var liten. Dette er basert på at strømretningen vil være perpendikulært på bølgeretningen gir liten vekselvirkning. Dette vil være relevant før bølgene påvirkes til å endre retning (refraksjon eller diffraksjon).

VEDLEGG C: FARTØYETS BEVEGELSER I FARVANNET

1. BAKGRUNNSINFORMASJON OM BEHANDLING AV AIS-DATA

1.1 AIS-data fra Kystverket

AIS-data ble hentet inn fra Kystverket om fartøyets bevegelser for dagen 7.10.2011.

Dataene inneholder Finnøyglimts posisjon, navigeringsstatus, fart over grunn, kurs over grunn, 'heading', 'ROT' og 'Timestamp' for hvert tidspunkt.

Alle tidspunkt er oppgitt i UTC.

Det var til sammen 3991 målepunkt for Finnøyglimt for tidsrommet 00:00:48 til 21:39:14. Etter at AIS-dataene var bearbeidet var det til sammen 3830 målepunkter. Kvaliteten på AIS-dataene vurderes til å være god.

I gjennomsnitt var det ett målepunkt for hvert 20. sekund. Mens fartøyet lå i ro frem til formiddagen ble det sendt færre AIS-signaler. Det lå også i ro en stund på kvelden frem til kl. 20:20.

1.2 Behandling av AIS-data

Det er valgt å rette spesiell oppmerksomhet fra det tidspunktet Finnøyglimt seilte fra kai kl. 20:20 og frem til siste målepunkt. I dette tidsrommet var det 562 målepunkter og i gjennomsnitt ett målepunkt for hvert 8,4 sekund:

- Dataene har blitt brukt for å synliggjøre fartøyets bevegelser i farvannet gjennom å ta skjermbilder av fartøyet fra Kystverkets AIS-tjeneste.

- Dataene har blitt brukt for å fremstille grafer med hastighet, kurs over grunn og akselerasjon.

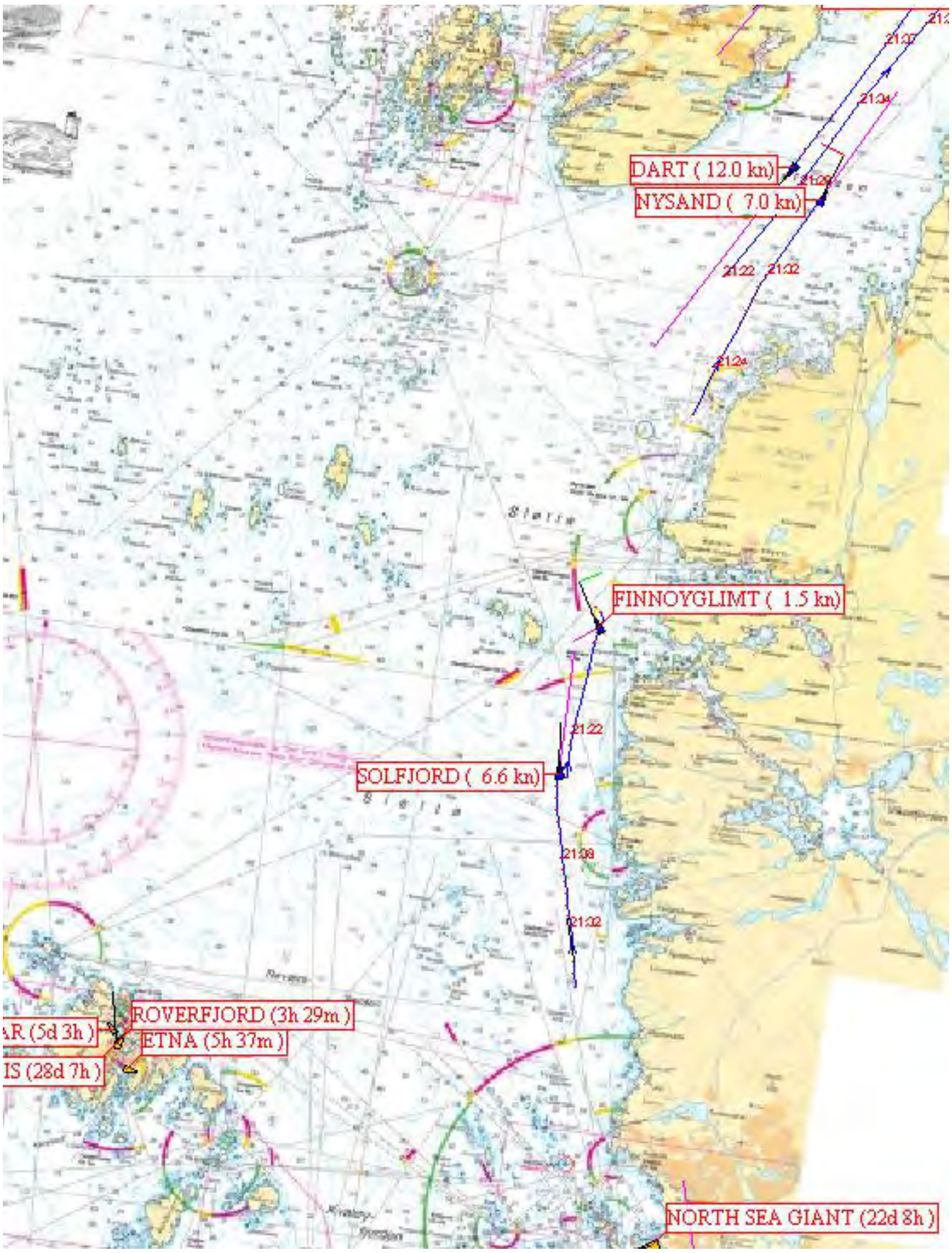
- Angående beregning av akselerasjon:

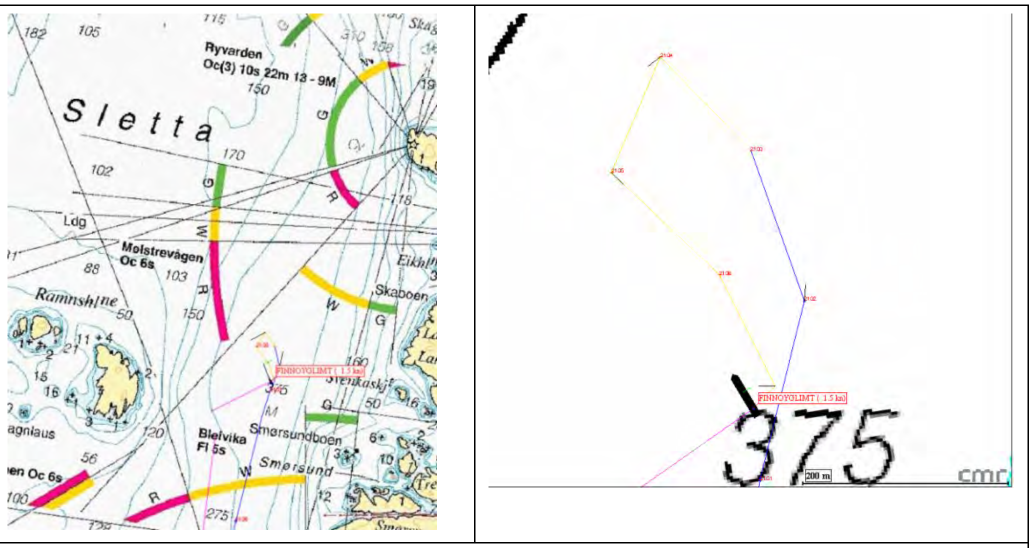
    - Basert på endring i hastighet og tidsdifferansen mellom tidspunktene hastigheten var blitt målt, ble det beregnet en gjennomsnittsakselerasjon. Beregningene har blitt presentert i punktdiagram. Det ble valgt å presentere resultatet som linjer (og ikke punkt for hver enkelt måling).

    - Da AIS-dataene kun har målinger i gjennomsnitt hvert 8. sekund (fra kl. 20:20) viser ikke AIS-målingene nødvendigvis de horisontale akselerasjonene fartøyet ble utsatt for. Dette fordi 1) Akselerasjonen kan ha vart kortere enn den tiden det har tatt mellom to målepunkter. Altså, akselerasjonene kan ha vært større enn det som er beregnet. 2) Det kan samtidig ha vært en kombinasjon av akselerasjon og retardasjon innenfor tidsrommet av to målepunkter. Et slikt tilfelle vil ikke kunne bli observert i beregningene. 3) Dette vil si at de beregnede akselerasjonene ikke nødvendigvis gjenspeiler de reelle akselerasjonene som fartøyet opplevde. Men tilfellene der det er beregnet større utslag av akselerasjoner kan indikere at det har vært større hastighetesendinger omkring disse tidsrommene.

- Disse fremstillingene ble sammenlignet med informasjon fra Kystverkets AIS-database og tidligere innhentet AIS-informasjon og radarbilder fra Kvitsøy (bilder som viser fartøyets posisjon). Bortsett fra radarbildene er kilden den samme under sammenligningen, nemlig Kystverkets database som igjen har hentet informasjonen fra Finnøyglimts egen AIS. Sammenligningen viste at det var samsvar.

1.3 Kart over fartøyets bevegelser før forliset





Figur 1: Kart som viser fartøyets bevegelser over Sletta og omkring forlistidspunkt

2. DRØFTING AV AIS-DATA

For hvert 10. minutt ble det laget en grafisk fremstilling som viser hastighet og kursendringer over tid. Tilsvarende ble det laget for akselerasjon og kursendringer over tid. Dette ble laget for tidsrommet 20:20 til 21:39 (UTC), dvs. fra da Finnøyglimt forlot Storesundflua til siste gang det ble mottatt AIS-signal fra Finnøyglimt. Se figurene nedenfor.

De fleste av de beregnede akselerasjonene var mindre enn 0,01 m/s^2. Et spørsmål er hva som er små og store akselerasjoner for fartøyet. Avreise fra Storesundflua kan gi en indikasjon på dette. Da fartøyet seilte fra kai og hastigheten økte fra 0,8 til 5,7 knop viser de beregnede akselerasjonene verdier mellom 0,14 og 0,23 m/s^2. Etter dette og mens fartøyet øker hastighet opp til 7,8 knop er nærmest samtlige verdier i underkant av 0,010 m/s^2.

Havarikommisjonens vurdering:
Havarikommisjonen antar at verdier opp til 0,23 m/s^2 vil være innenfor vanlig operasjon. Det observeres også verdier større enn 0,05 m/s^2 og opp til 0,103 m/s^2. Verdier større enn 0,05 m/s^2 velges for en nøyere vurdering.

2.1 Tidspunkt der akselerasjonen var større enn 0,05 m/s^2

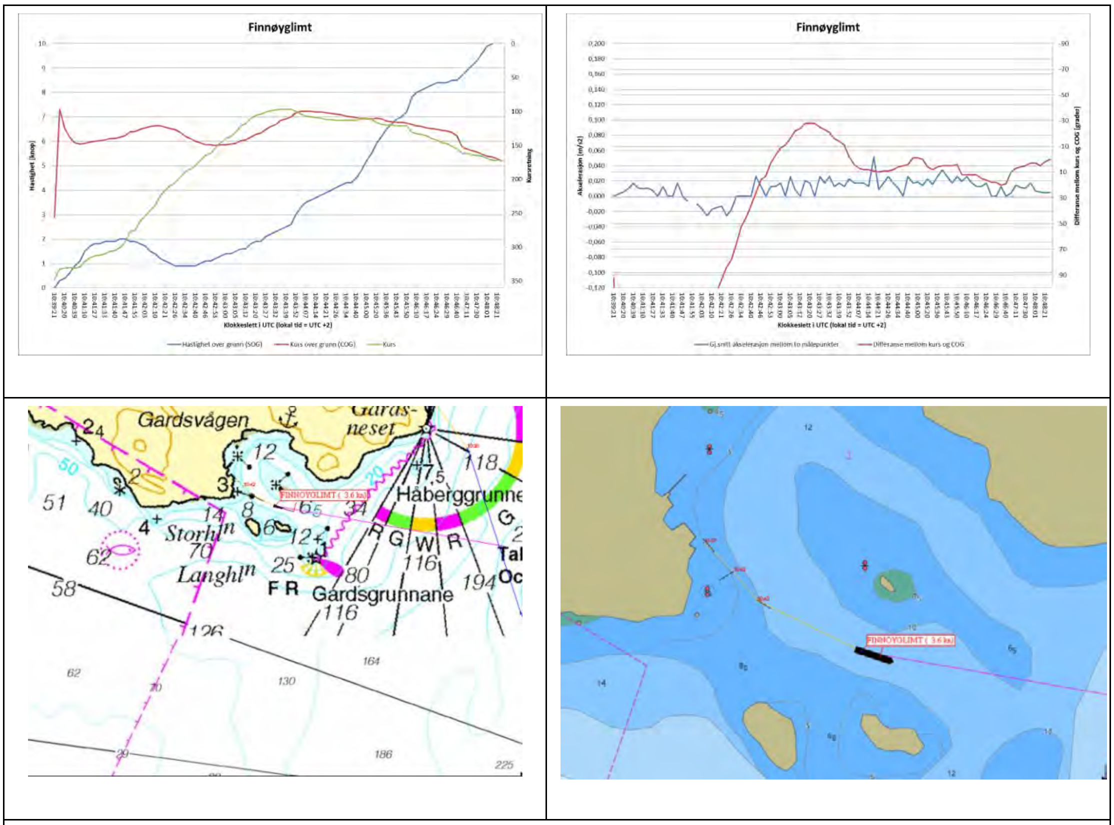
I følgende tilfeller var den absolutte akselerasjonen større enn 0,05 m/s^2:

Latitude	Longitude	Date	Time	Hastighet over grunn (SOG)	Kurs over grunn (COG)	Kurs	Gj.snitt akselerasjon mellom to målepunkter
59,1001183	5,8463133	7.10.2011	10:44:15	3,8	101	110	0,051
59,08425	5,8298267	7.10.2011	16:06:18	8	340	331	-0,051
59,3650167	5,2993617	7.10.2011	19:23:52	6,2	344	355	-0,051
59,424235	5,2299883	7.10.2011	20:40:26	6,6	337	353	-0,051

Latitude	Longitude	Date	Time	Hastighet over grunn (SOG)	Kurs over grunn (COG)	Kurs	Gj.snitt akselerasjon mellom to målepunkter
59,4518	5,2250617	7.10.2011	20:55:40	6,2	357	1	-0,051
59,4599717	5,223525	7.10.2011	21:00:32	5,7	345	338	-0,103
59,4623633	5,2220917	7.10.2011	21:02:09	5,4	342	343	-0,051
59,5124683	5,2120467	7.10.2011	21:33:16	5	336	333	-0,051
59,5127917	5,20918	7.10.2011	21:35:19	4,1	198	150	0,103
59,5112267	5,2120917	7.10.2011	21:36:56	5,3	132	199	-0,051
59,5110183	5,21222	7.10.2011	21:37:07	4,6	147	229	-0,051
59,5108133	5,2121733	7.10.2011	21:37:19	3,8	165	256	-0,051
59,5107	5,2120917	7.10.2011	21:37:30	3	179	270	-0,051

2.2 Kl. 10:44:15

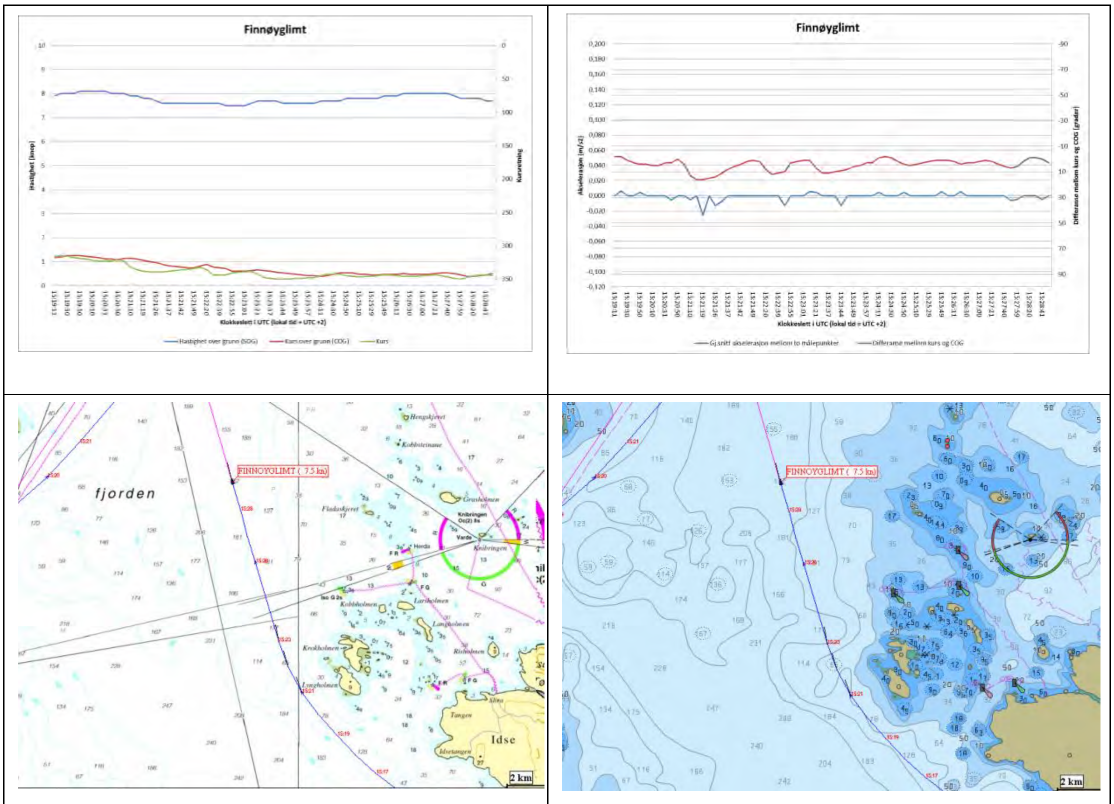
Finnøyglimt legger fra kai i Gardsvågen, Talgje, nordsiden av Brimsefjorden. Dette er like etter at fartøyet har ligget i ro. Hastigheten er bare mellom 3 og 4 knop og fartøyet har manøvrert ferdig ut fra kai. Det er noe differanse mellom kursene da den største akselerasjonen var 0,051 m/s^2.



Figur 2:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

2.3 Kl. 15:21:19

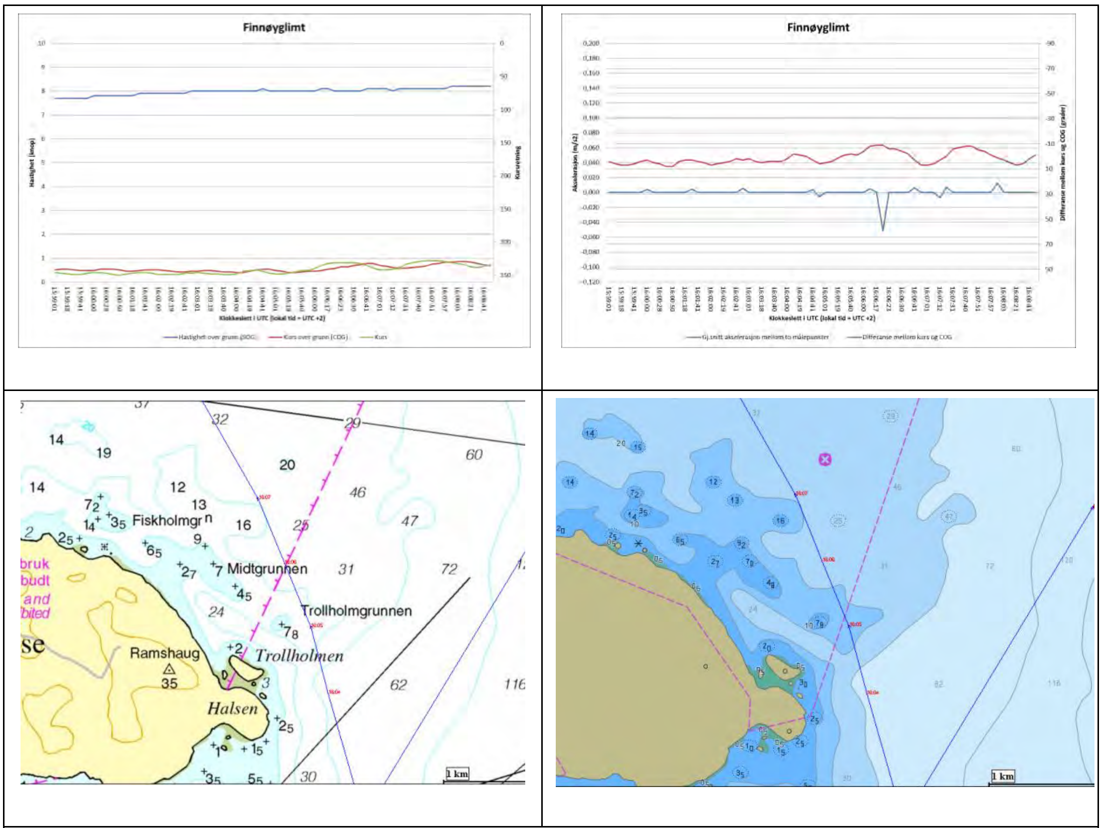
Horgefjorden. Akselerasjonen oppstår i forbindelse med en kursendring. Finnøyglimt seiler over 80-meterskoten og kommer kl. 15:21 i farvann som er mer eksponert for vind og sjø fra nord. Utslaget er mens differansen mellom kurs og COG er større. Hastigheten reduserte noe over noen minutter fra 8 til 7,5 knop. Største akselerasjonen var -0,026 m/s^2.



Figur 3:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

2.4 Kl. 16:06:18

Utslaget er i etterkant av at differansen mellom kurs og COG er større. Hastigheten var konstant på omkring 8 knop. Største akselerasjonen var -0,051 m/s^2.



Figur 4:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

2.5 Mellom kl. 17:03 og 19:27

Lave akselerasjoner, men større utslag i kursdifferanse (>9) observert for tidspunktene 17:03, 17:07, 17:08, 17:10, 17:11, 17:14, 17:15, 17:16, 17:17, 17:19, 17:20, 17;21, 17;23, 17:24, 17:25, 17:26, 17:28, 17:30, 17:31, 17:34, 17:36, 17:37, 17:47, 17:54, 18:06, 18:07, 18:18, 18:25, 18:51, 18:59, 19:12, 19:14, 19:15, 19:25, 19:27

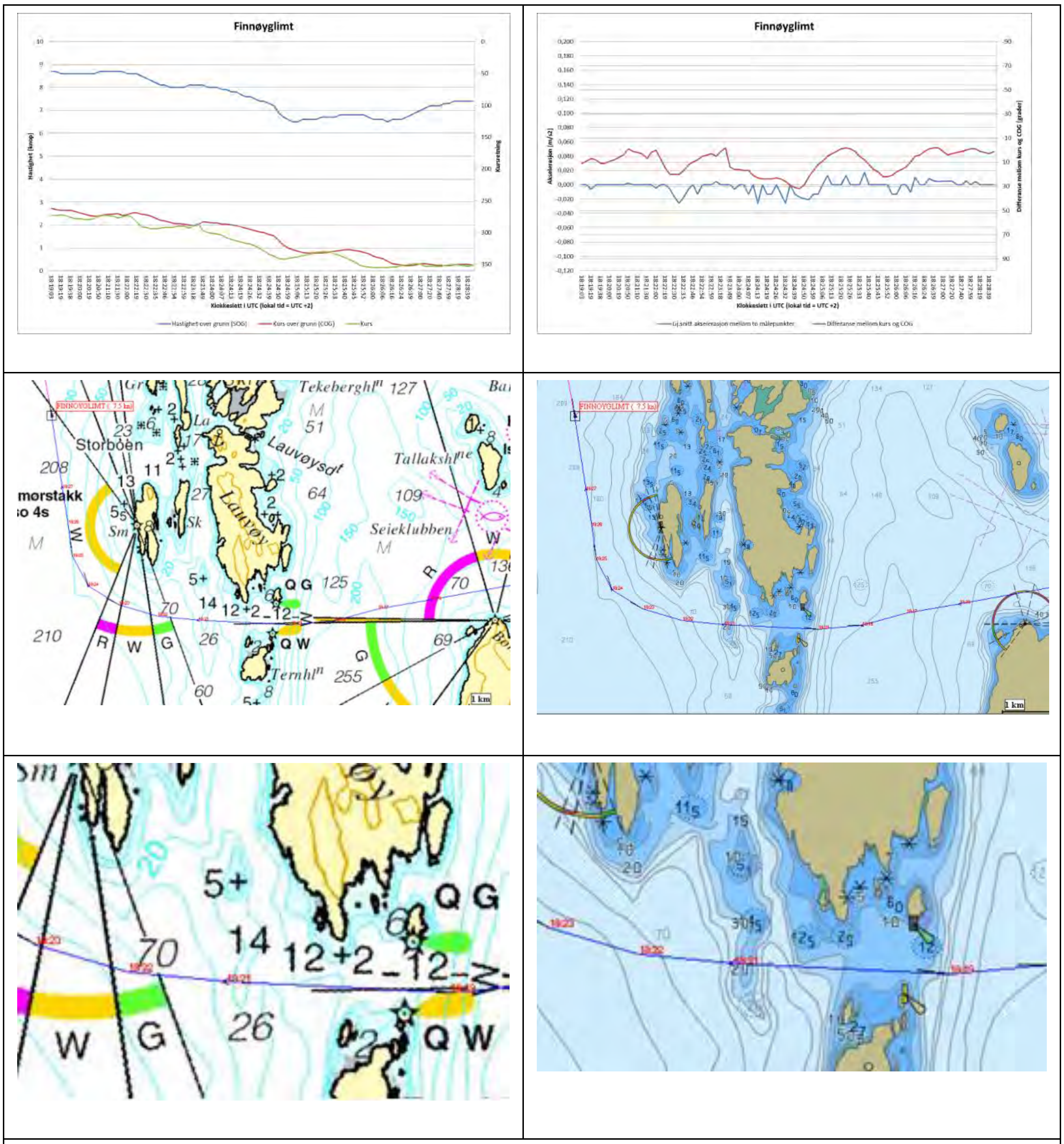
I tidsrommet 16:45 – 17:39 ligger kurs jevnt mot styrbord i forhold til COG.

Havarikommisjonens vurdering er at fartøyet drifter mot babord pga. vind eller strøm mot styrbord side. Omkring kl. 17:47 øker differansen mellom kurs og COG, men uten at akselerasjonene er større.

2.6 Kl. 18:22 – 18:24

Syd for Smørstakk, 550 meter etter å ha passert mellom Lauvøy og Ternholmen. Dette er mens fartøyet endrer kurs fra vest til nord (runder Smørstakk). Maksimale akselerasjoner var -0,026.

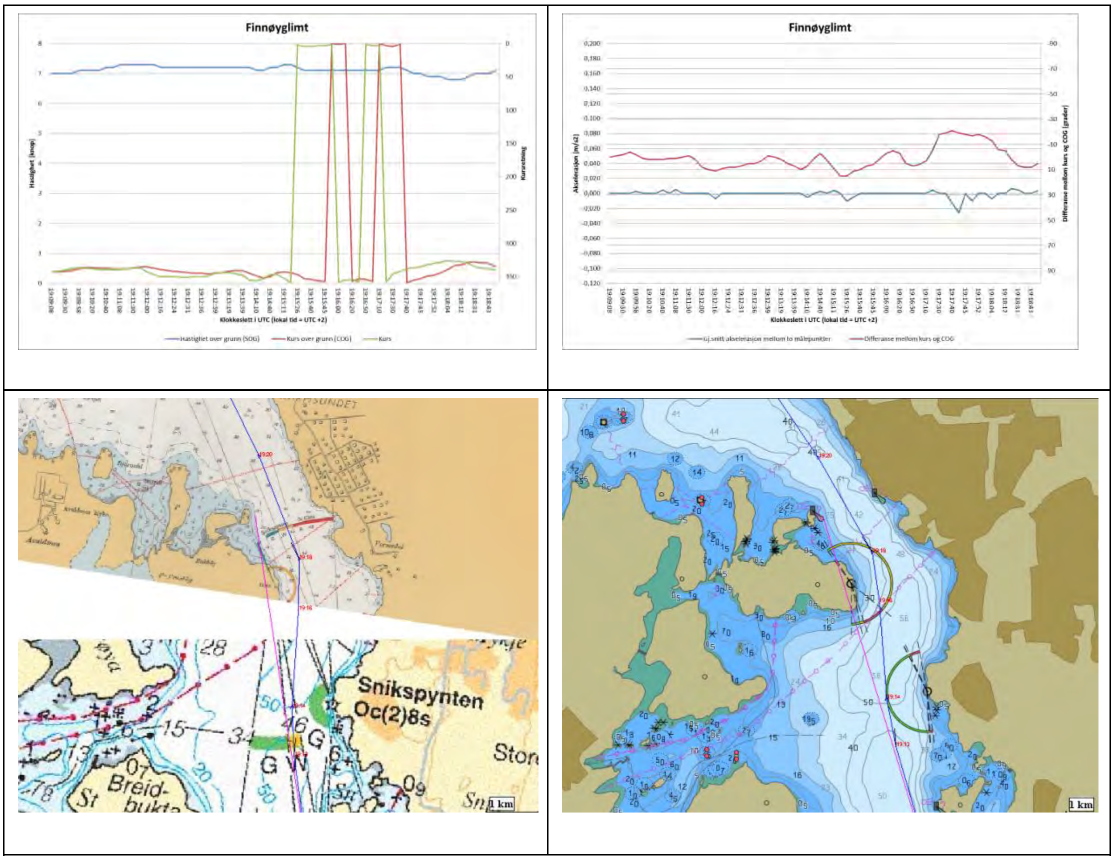
Havarikommisjonens vurdering er at sjøen er mer ruglete enn tidligere.



Figur 5:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

2.7 Kl. 19:17:42

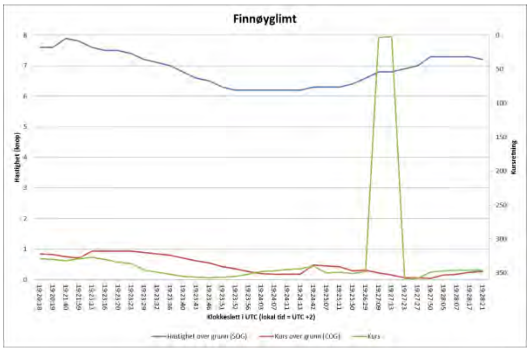
På høyde med sektorlyset ved Bukkøya. Utslaget er i etterkant av at differansen mellom kurs og COG er større. Hastigheten var konstant på omkring 7 knop. Største akselerasjonen var -0,026 m/s^2.

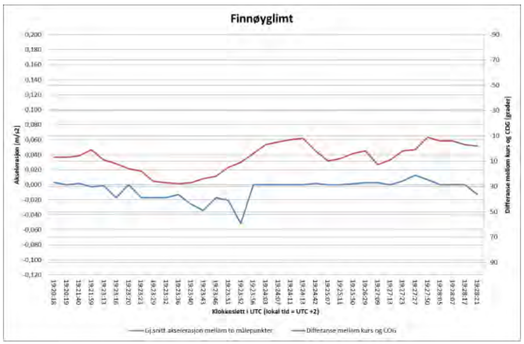


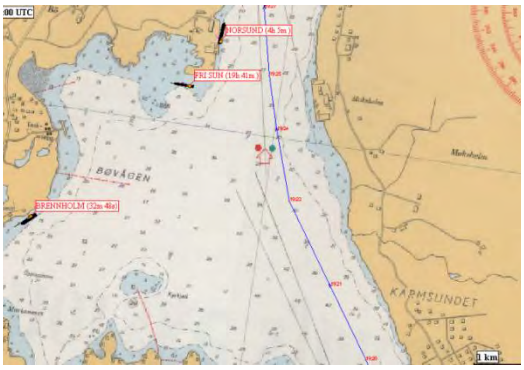
Figur 6:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

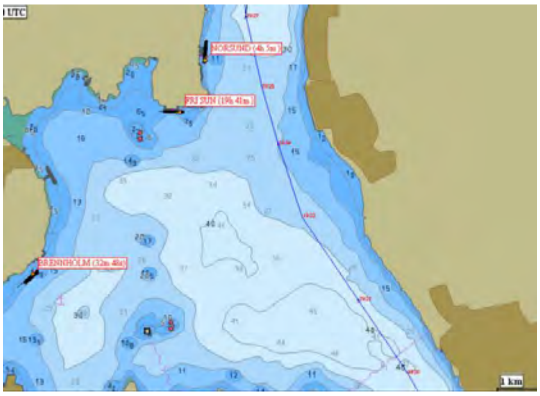
2.8 Kl. 19:23:52

Syd for Salhusbroen i Karmsundet. På høyde med Bøvågen. Dette er da fartøyet endrer kurs mot styrbord. Utslaget er i etterkant av at differansen mellom kurs og COG er større. Dette er over et tidsrom på ca. 8 minutter der hastigheten har blitt redusert fra 8 til 6 knop for igjen å øke til 7,5 knop. Største akselerasjonen var -0,051 m/s^2.







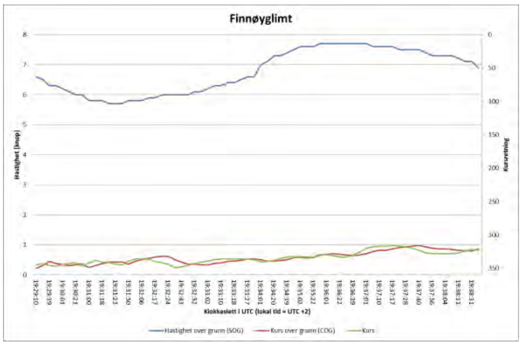


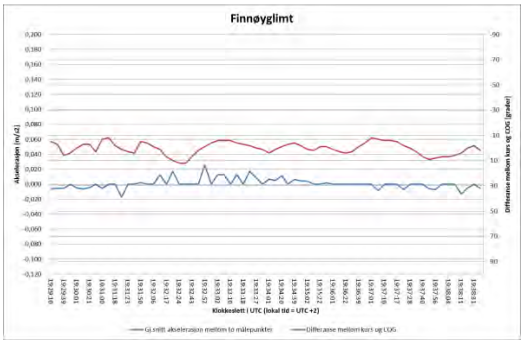
Figur 7:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

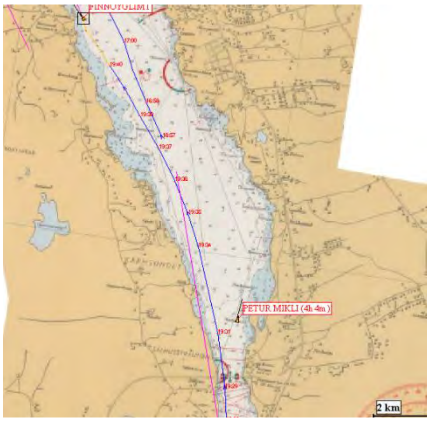
2.9 Kl. 19:32:52

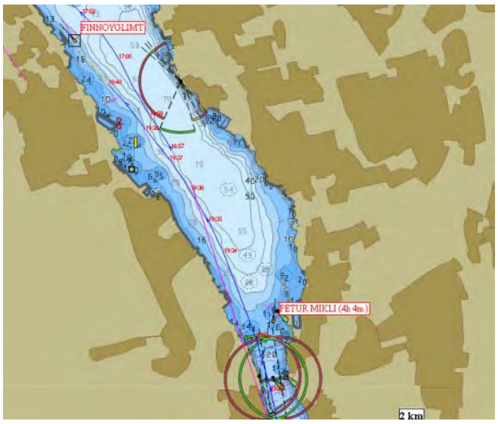
Nord for Salhusbroen i Karmsundet.

Utslaget er i etterkant av at differansen mellom kurs og COG er større. Dette er over et tidsrom på ca. 10 minutter der hastigheten har blitt redusert fra 7,5 til 6 knop for igjen å øke til 7,5 knop. Største akselerasjonen var 0,026 m/s^2.







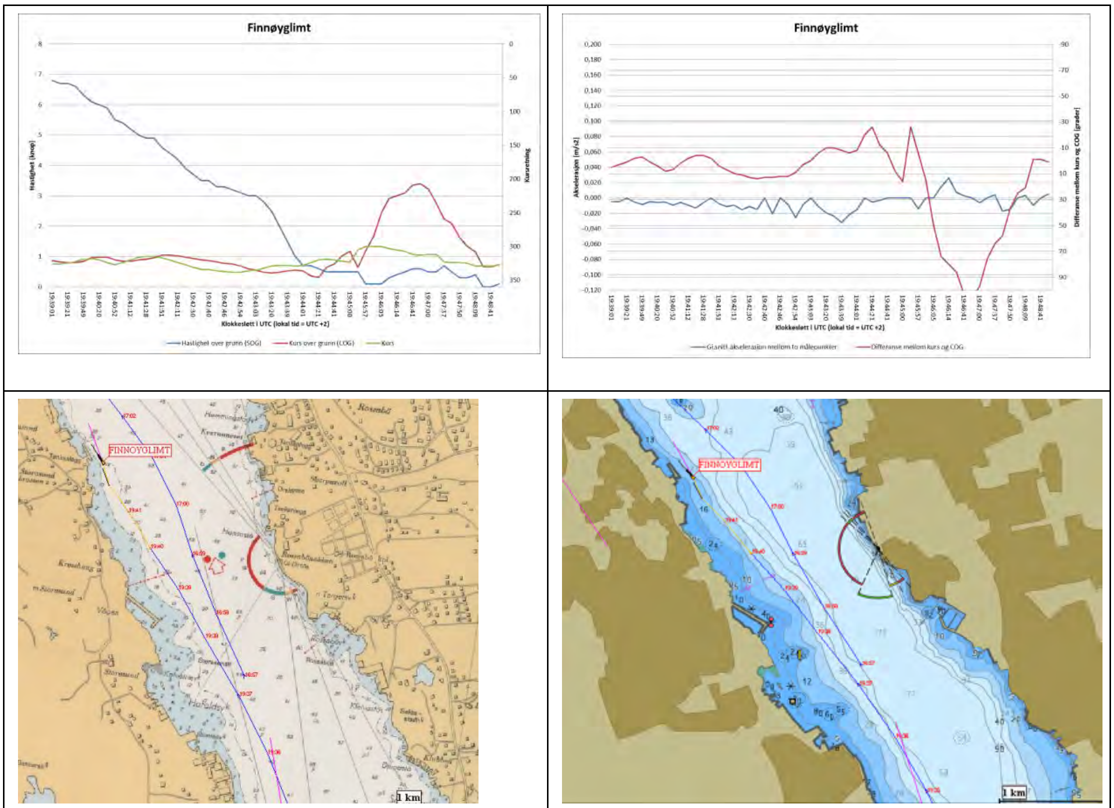


Figur 8:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

2.10 Kl. 19:42-19:46

Ved tankanlegget i Storesund.

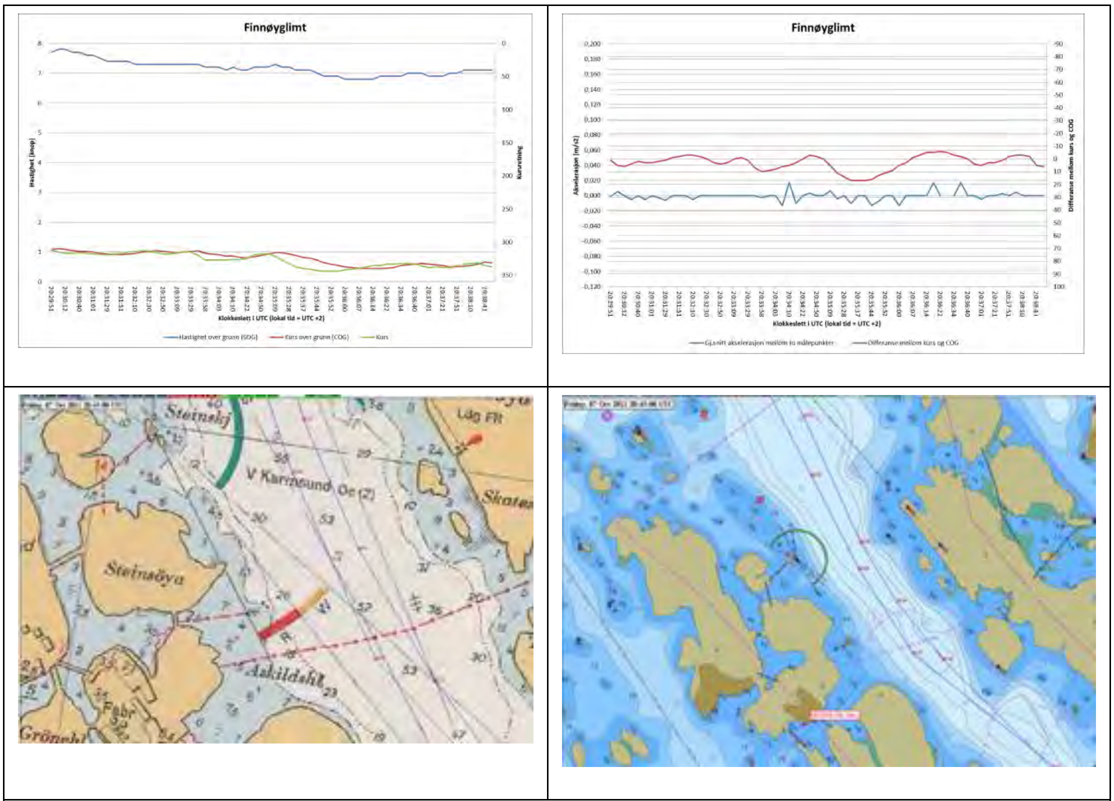
De større akselerasjonene og kursdifferansene oppstår etter at hastigheten har blitt redusert til under 3 knop. Det antas derfor at disse oppstår i forbindelse med at fartøyet legger til kai. De beregnede gjennomsnitt-akselerasjonene på opptil -0,032 kan derfor oppstå når fartøyet legger til ved kai.



Figur 9:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

2.11 Kl. 20:34:07:

Dette området er tatt med for å sammenligne med kl. 20:40.

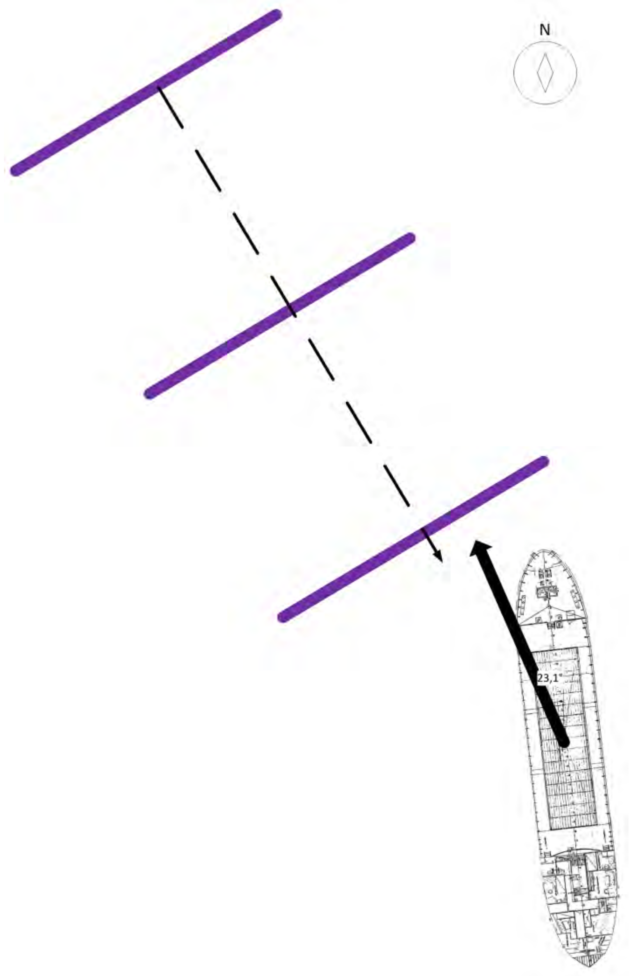


Figur 10:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

2.12 Kl. 20:40 – 20:41 –Vest for Sørhaugøya

Fartøyet hadde noen akselerasjoner på 0,017 – 0,034 m/s^2. Dette var i et område der fartøyet seilte fra grunnere til noe dypere vann og med noe bråere endring i dybden. Det er vurdert til at vindsjøen forårsaket akselerasjonene på fartøyets bevegelser i dette tidsrommet.

Kl. 20:40:26 hadde fartøyet kurs 353 grader, COG 337 grader og hastighet 6,6 knop. På dette tidspunktet er det en beregnet akselerasjon på -0,051 m/s^2. Posisjonen er ved vestlig side av 20-meters kotekant. Det oppgis to dybder innenfor kotekanten på hhv 15 og 12 meter. Som det fremgår av det elektroniske sjøkartet endrer bunntopografien seg raskere i dette området. I øst-vest retning endrer dybden seg fra 50 til 20 meter over en horisontal avstand på 40 meter.

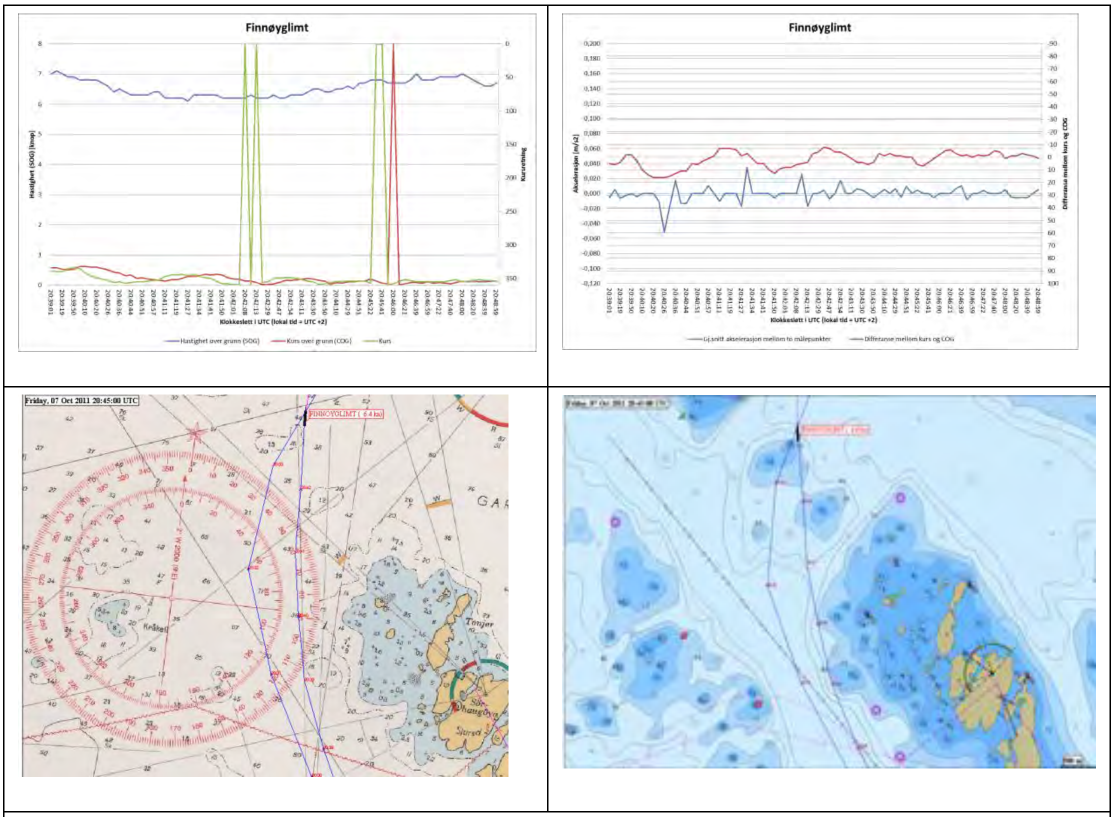


Figur 11: Illustrasjon av fartøyets kurs, COG (svart heltrukken pil) og bølgenes retning kl. 20:40:26. Blå streker illustrerer bølgekammen til vindsjø. Avstanden mellom bølgekammene er ikke proporsjonalt med fartøyets størrelse.

Fra de beregnede akselerasjonene er det noe større verdier (dvs. > 0,01 m/s^2) frem til kl. 20:40:44. Dette er i det tidsrommet fartøyet seiler langs denne endringen i dybde. Fartøyet seiler over tilsvarende topografi frem til kl. 20:41:59. I dette tidsrommet fremkommer det kun to etterfølgende akselerasjoner som var større enn 0,01 m/s^2 (hhv 0,017 og 0,034). Disse var i området der fartøyet var over dybder på 40 og 50 meter. Fartøyet hadde rett før seilt fra grunnere (< 40 meter) til dypere vann (> 40 meter).

Havarikommisjonens vurdering:

I dette området var farvannet skjermet for dønninger fra vest. Fartøyets endrede bevegelser var antageligvis som følge av vindsjø fra nordvest som kom over grunnere vann og på den måten ble høyere og steilere. Rett vest for Sørhaugøya stampet antageligvis fartøyet som følge av at det seilte fra grunnere til markant dypere vann.



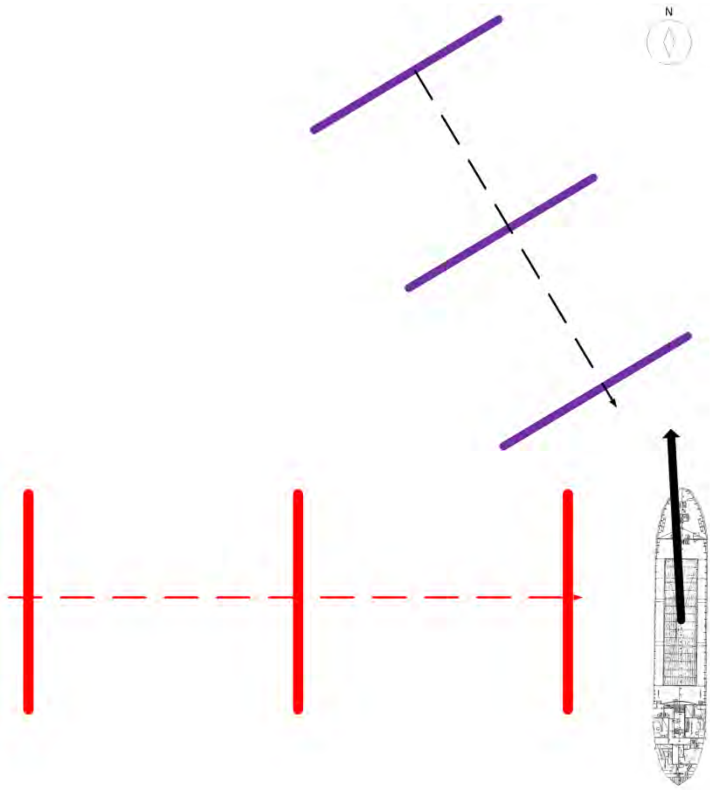
Figur 12:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

2.13 Kl. 20:54:27 - 20:55:40 – Syd for Tømmerflua:

I dette området hadde fartøyet noe større forskjell mellom kurs og COG og med påfølgende akselerasjon på -0,051 m/s^2.

Kl. 20:55:40 var fartøyet ved Tømmerflua og seilte over den syd-østre siden av 50-meterskoten. Kl. 20:55:40 var kurs 1 grad, COG 357 grader og hastighet 6,2 knop.

Like før dette tidspunktet var differanse mellom kurs og COG opp til 11 grader. Dette var omkring kl. 20:54:34. Kl. 20:55:40 var det en beregnet akselerasjon på -0,051 m/s^2.



Figur 13: Illustrasjon av fartøyets kurs, COG (svart heltrukken pil) og bølgenes retning kl. 20:55:40. Blå og rød streker illustrerer henholdsvis bølgekammen til vindsjø og dønninger. Avstanden mellom bølgekammene er ikke proporsjonalt med fartøyets størrelse. Det er usikkerheter om retningen til dønningene, men disse kan ha virket mot fartøyets babord baug og låring.

Bølgeforhold: På Sletta fra høyde ved Klaven til Sørhaugøy var det dybder på omkring 50 – 100 meter. Fartøyet seilte over dette området mellom kl.20:45 – 21:03. Vest for dette området skjermet Røvær for dønninger fra vest.

I området mellom Nordre Skolten og Grunnane var det dybder på 120 – 50 meter. Øst for dette området ligger Tømmerflua. På dette strekket kan fartøyet ha vært eksponert for dønninger fra vest.

Tømmerflua har dybder på omkring 50 meter. Nord for Tømmerflua var det dypere.

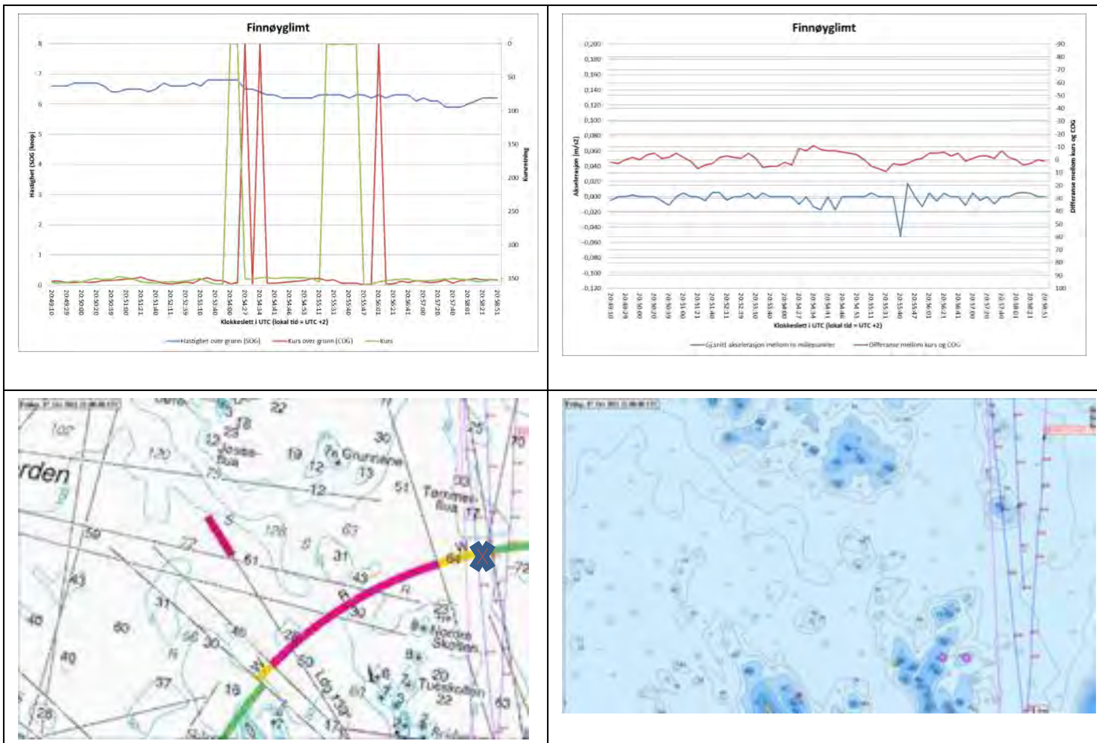
Et område langs land nordøst for Tømmerflua strekker seg over 240 meter. Der er det brått grunnere rett langs land. Retningen er sammenfallende med retningen til vindsjø.

Havarikommisjonens vurderinger:

Vindsjøbølgene kan ha blitt stuvet noe mer sammen over Tømmerflua og kan dermed også ha medvirket til fartøyets endrede bevegelser i dette området. Det er også en mulighet for at vindsjø har reflektert i land nordøst for denne posisjonen slik at dette har forsterket bølgehøydene i det området fartøyet seilte på denne tiden.

Dønningene kan ha blitt høyere og kortere som følge av stuving. Dette kan forklare observasjonen om at fartøyet dreide til siden i dette tidsrommet og med påfølgende retardasjon.

Disse endringer i fartøyets bevegelser kan forstås ved at fartøyet i dette området ble eksponert for dønninger fra vest i tillegg til vindsjø fra nordvest. Særlig vindsjøen fra nordvest kan i dette området ha blitt høyere og steilere som følge av stuving over et grunnere område. Da fartøyet seilte over Tømmerflua var fartøyet antageligvis eksponert for både vindsjø mot babord baug og dønninger mot babord side. På grunn av bunnforholdene kan bølgene ha blitt stuvet sammen i dette området slik at fartøyet fikk større stamp-, jag- og rullebevegelser.

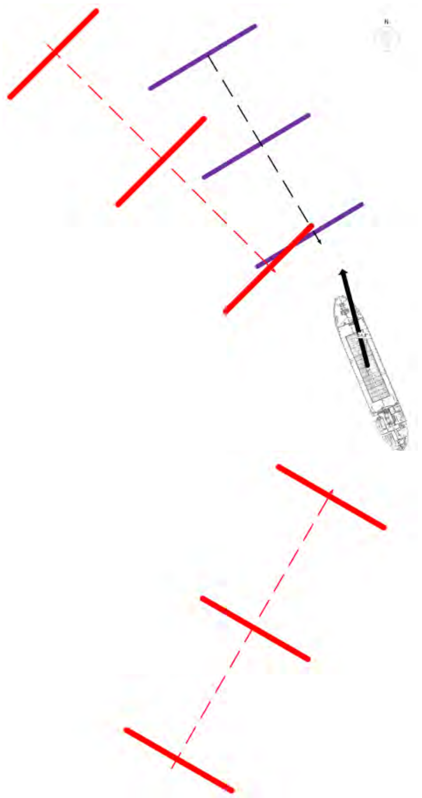


Figur 14:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

2.14 Kl. 21:00:32 – 21:06:27 Nord for Tømmerflua til høyde med Sørhaugøy

Fartøyet var like nord for Tømmerflua. Omkring kl. 21:00 foretas det en kursendring til babord. Dette er der sektorlyset fra Blevika endres fra hvitt til grønt. Kursendringen medfører større forskjell mellom kurs og COG. Kursdifferansen viser at COG følger etter kurs over tidsrommet 21:00:01 – 21:00:51. Deretter svinger kursdifferansen over 0-verdien. Det er vurdert til at selve kursendringen var bevisst utført av navigatøren.

Kl. 21:00:32 er det en beregnet akselerasjon på -0,103 m/s^2. Dette er en av de få maksimale akselerasjonene som har blitt observert. På dette tidspunktet var kurs 338 grader, COG 345 grader og hastighet 5,7 knop.



Figur 15: Illustrasjon av fartøyets kurs, COG (svart heltrukken pil) og bølgenes retning kl. 21:00:32. Blå og rød streker illustrerer henholdsvis bølgekammen til vindsjø og dønninger. Avstanden mellom bølgekammene er ikke proporsjonalt med fartøyets størrelse. Det er usikkerheter om retningen til dønningene, men disse kan ha virket mot fartøyets babord baug og låring.

Kl. 21:01:18. I forkant av denne akselerasjonen observeres det kursdifferanse på opp til 14 grader. Deretter er det en akselerasjon på -0,026 m/s^2. Dette er 46 sekunder etter forrige akselerasjon.

Kl. 21:02:09 er det beregnet en akselerasjon på -0,051 m/s^2. Dette er 51 sekunder etter forrige akselerasjon og 1 minutt og 37 sekunder etter den store akselerasjonen (kl. 21:00:21).

Fra kl. 21:05:50 til 21:06:27: Omkring disse to tidsrommene var det større kursdifferanse samt flere akselerasjoner. Den største var -0,034 m/s^2.

I dette tidsrommet seilte fartøyet fra like nord for Tømmerflua og til opp på høyde med Sørhaugøy og Stora Bleiskjer.

Farvannet fartøyet seilte over i dette tidsrommet hadde dybder mellom 50 meter og 100 meter.

Nord for området var det dybder på mellom 100 og 150 meter.

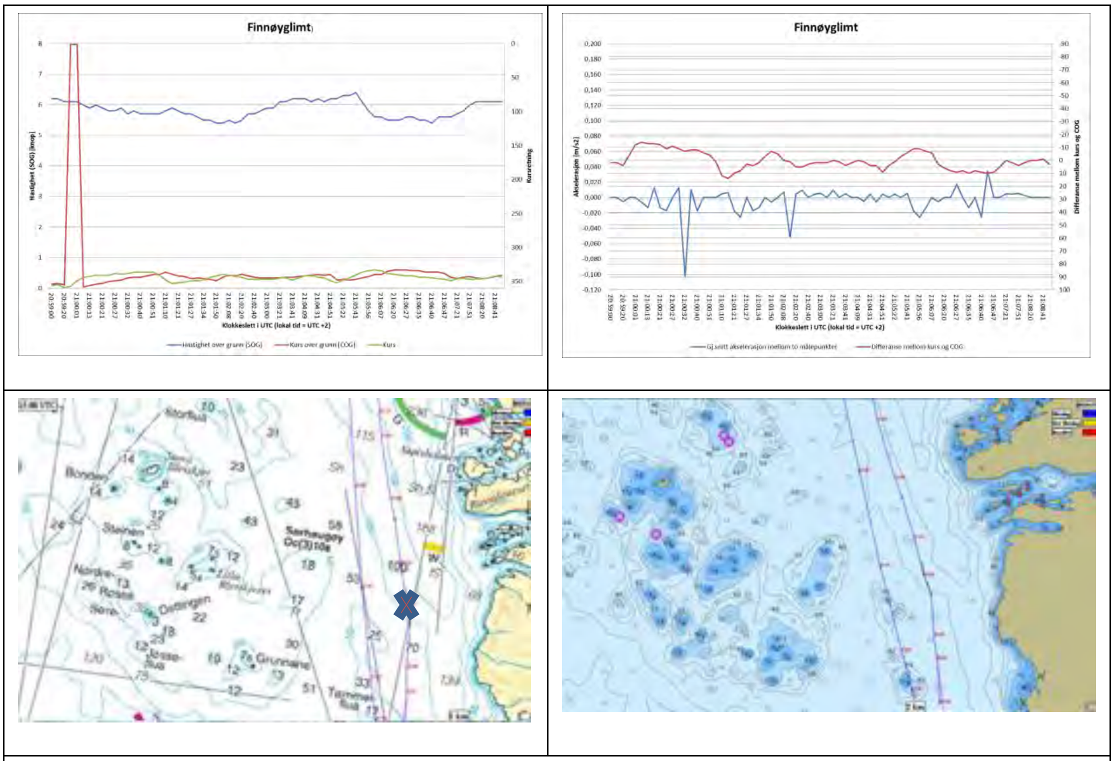
Store og Litla Bleiskjær, Bonden, Steinen og grunnene Rosse, Dettingen, Jøsseflua og Grunnane var vest for fartøyet. Disse grunnene hadde dybder fra 25 til 4 meter. Vest for grunnene var det dypere vann.

Øst for fartøyet ble det brått grunnere nærme land. Land består av dype viker, spisse nes, holmer og skjær.

Havarikommisjonens vurderinger:

I dette området ble fartøyet eksponert for dønninger fra vest i tillegg til vindsjø fra nordvest. Dønningene som kom fra vest kan ha blitt stuvet slik at de ble høyere og steilere samt at de kan ha endret retning. Dette kan ha ført til at det først oppstod en bølgerefraksjon på losiden for deretter en bølgediffraksjon på lesiden. Dette kan ha oppstått både syd for og nord for området med grunner. Som konsekvens av dette kan bølgene fra hver sin side ha gått mot hverandre og når disse har møttes har det oppstått et mer kaotisk bølgemønster med høyere bølger.

Endringer i fartøyets bevegelser i dette området kan hovedsakelig forstås ved at fartøyet seilte i et område som var i lesiden av et område med grunner, skjær og holmer. I dette området kan dønningene fra vest blitt påvirket av bunnforholdene slik at det ble refraksjon og diffraksjon og at det dermed har oppstått et kaotisk bølgemønster med høyere bølger. I løpet av de neste 6 minuttene hadde fartøyet flere større akselerasjoner, noe som indikerer større stamp-, jag-, og rullebevegelser. Disse var antageligvis forårsaket av kombinasjonen vindsjø mot baug samt høyere dønninger. Disse dønningene hadde antageligvis blitt påvirket av grunner og skjær slik at de var høyere og hadde skiftet retning. Dønningene kan derfor ha vært mot fartøyets babord låring og deretter mer mot babord baug.

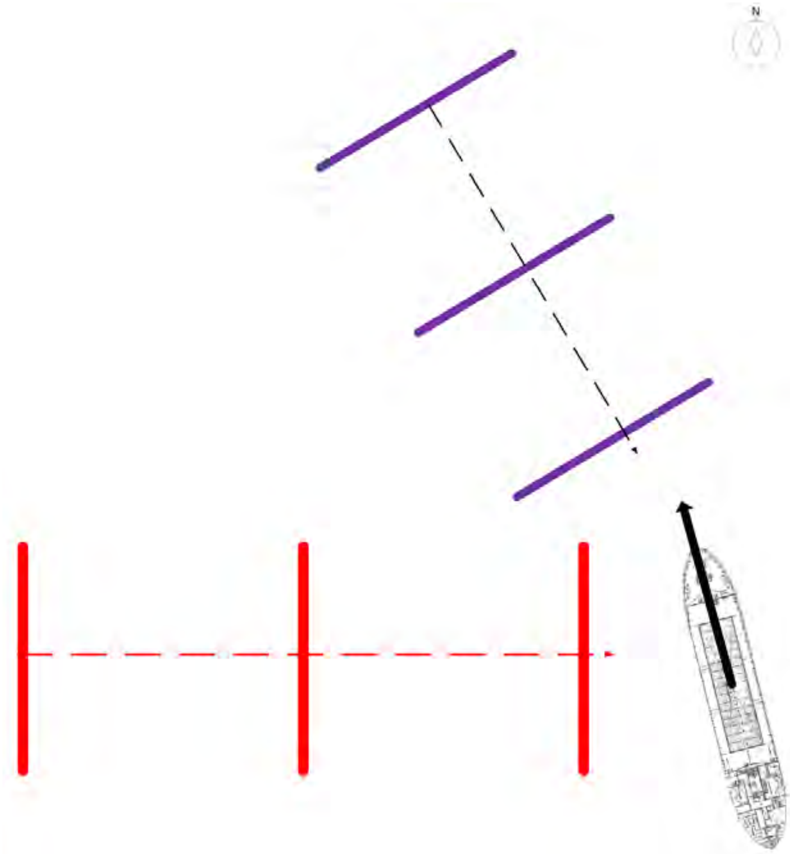


Figur 16:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

2.15 Mellom kl. 21:07 og 21:32

Det observeres ingen større akselerasjoner (dvs. akselerasjoner > 0,023). Det observeres heller ingen større kursdifferanser.

Kl. 21:07:11 var kurs 349 grader, COG 344 grader og hastighet 5,9 knop. Kl. 21:32:19 var kurs 9 grader, COG 15 grader og hastighet 5,7 knop.



Figur 17: Illustrasjon av fartøyets kurs, COG (svart heltrukken pil) og bølgenes retning kl. 21:07:11. Blå og rød streker illustrerer henholdsvis bølgekammen til vindsjø og dønninger. Avstanden mellom bølgekammene er ikke proporsjonalt med fartøyets størrelse.

Kl. 21:09 var fartøyet vest for Stølsholmen, sydvest for Bleivika, like før Sletta. Kl. 21:19 var fartøyet på Sletta, nordvest for Bleivika. Kl. 21:30:00 var fartøyet mellom Ramnsholmene og Trettøya.

Dybdeforholdene som fartøyet seilte over var på mellom 150 og 300 meter. Vest for dette området var dybdene mellom 100 og 300 meter.

Øst og nordøst for fartøyet var det hovedsakelig land. Nærme land avtar dybden fra 50 til 0 m over en horisontal lengde på omkring 130 meter. Landet består av mange nes og viker.

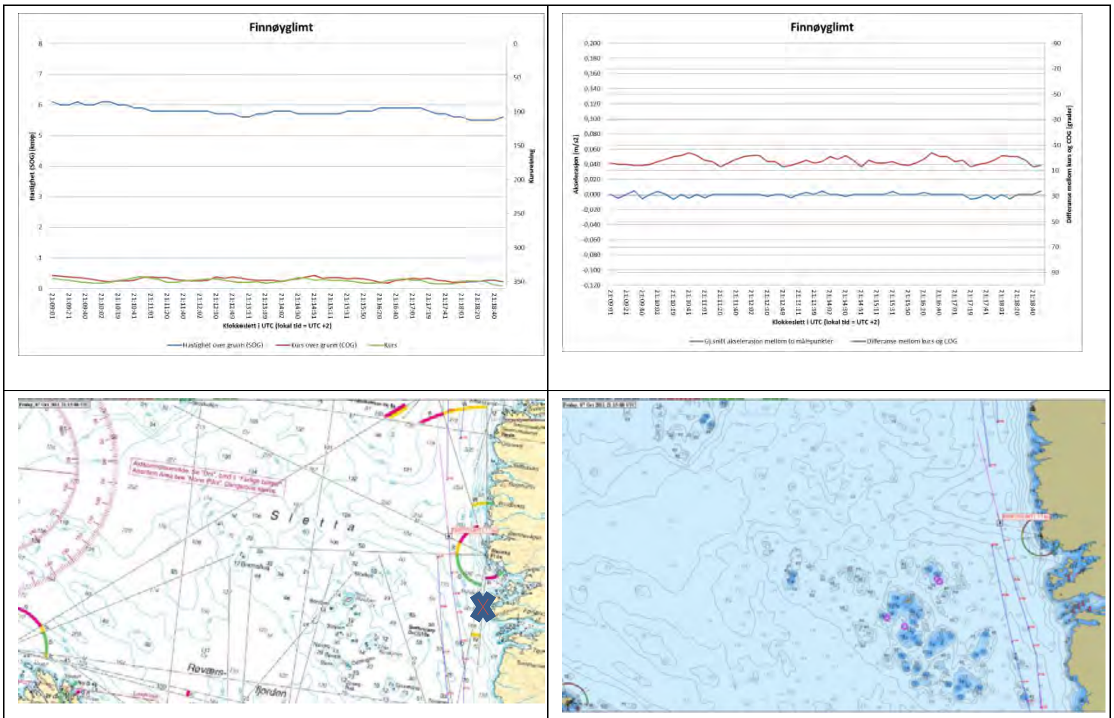
Det er først omkring kl. 21: 23 at det var en mindre grunne på 50 meter vest for fartøyet. Avstanden mellom dette området og fartøyet var 0,76 n.mil (1,4 km). Men etter denne grunnen blir det dypere igjen, og derfor ville eventuell stuvinger avtatt som følge av at bølgene kom over i dypere vann.

Lenger vest og nord for dette området (dvs. fra der fartøyet var kl. 21:23) lå Gåseskjærene. Disse lå 2,8 n.mil (5,2 km) vest for der fartøyet seilte. Gåseskjærene består av flere grunner og skjær i syd-nord retning over et område på 1,2 km. Vest for disse skjærene er det grunnere vann med dybder på mellom 10 og 50 meter.

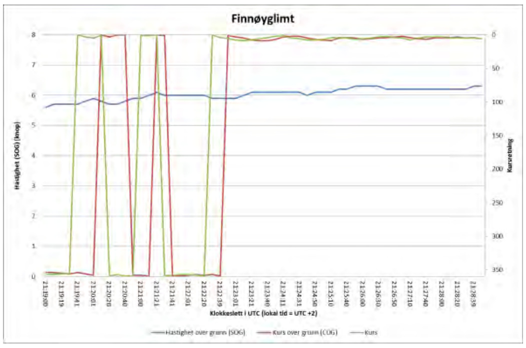
Forutsatt at det var en tidestrøm mot nord på dette tidspunktet kan topografien ha medført at strømmen økte i hastighet fra der fartøyet var omkring 21:23 og senere. Denne vurderingen er basert på at det blir grunnere vann, holmer og skjær mot vest, mens bunnen mellom Rennholmen og Bleivika former en dypere renne. Dette vil føre til at en strøm rant lettere over denne rennen enn over grunnene mot vest. Men da det er stor usikkerhet omkring strømforholdene kan det ikke konkluderes med at dette har bidratt til å påvirke vindsjøen og de reflekterte bølgene.

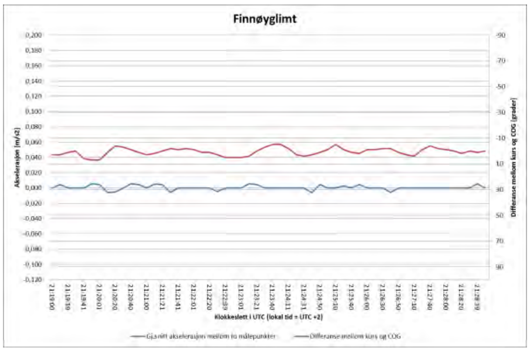
Havarikommisjonens vurderinger:

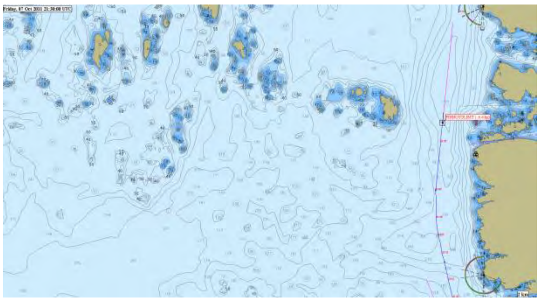
I dette området har det vært liten vekselvirkning mellom bølgene og bunnforholdene. Det kan muligens ha vært noe refleksjon av bølger fra land som lå øst for fartøyet. Fartøyet fikk vindsjø mot baug og etter hvert babord baug. Dønninger kom mot fartøyets babord side. Etter kl. 2323 kan grunner, holmer og skjær ha tatt av for dønningene fra vest. Fra Stølsholmen og nordover kan vindsjøen ha vært noe skjermet for holmer og skjær. Da det ikke observeres større akselerasjoner hadde fartøyet antageligvis lite stamp i dette tidsrommet. Dønningene kan ha gitt fartøyet noe jag og rullebevegelse.



Figur 18:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

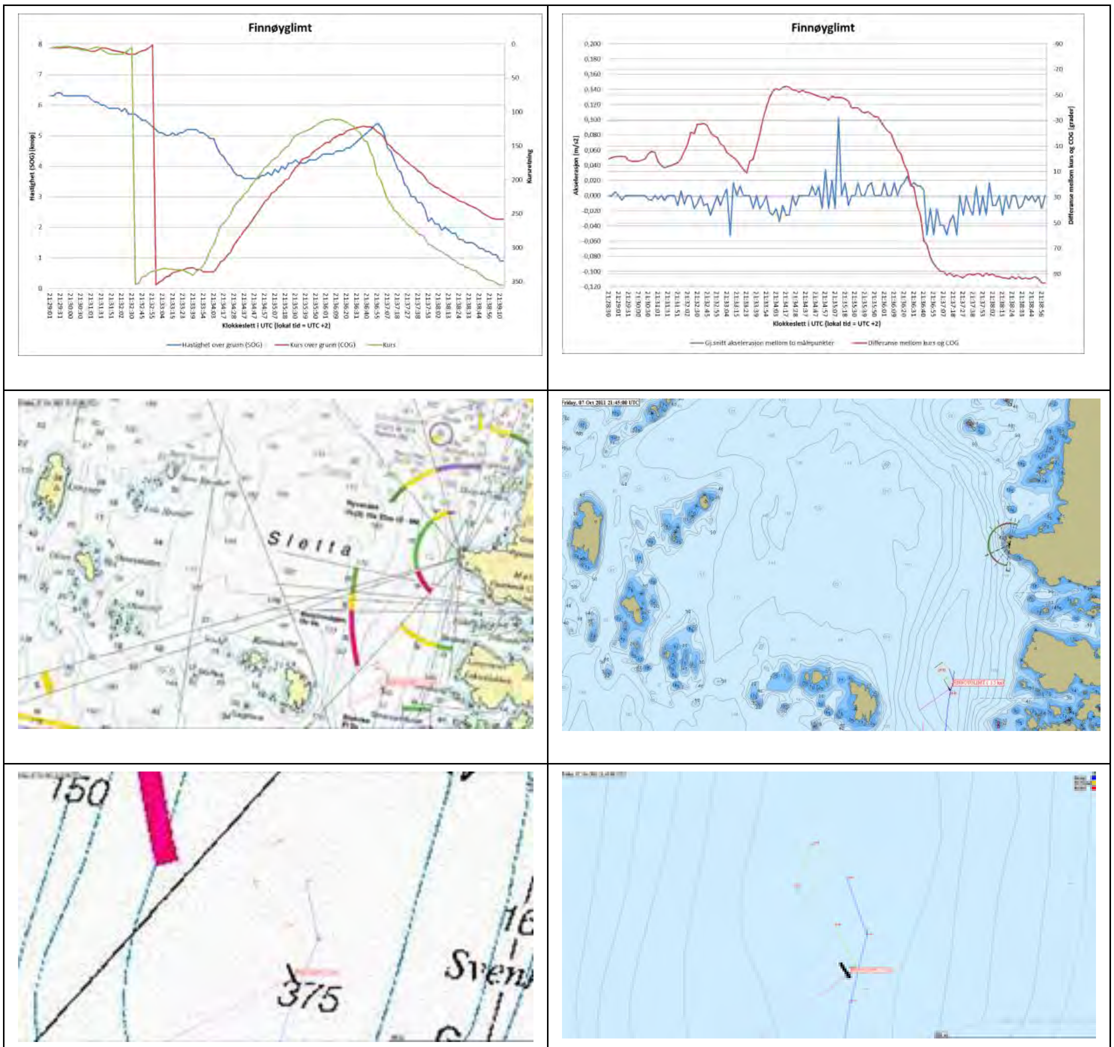






Figur 19:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

2.16 Grafer for tidsrommet 21:29 – 21:39

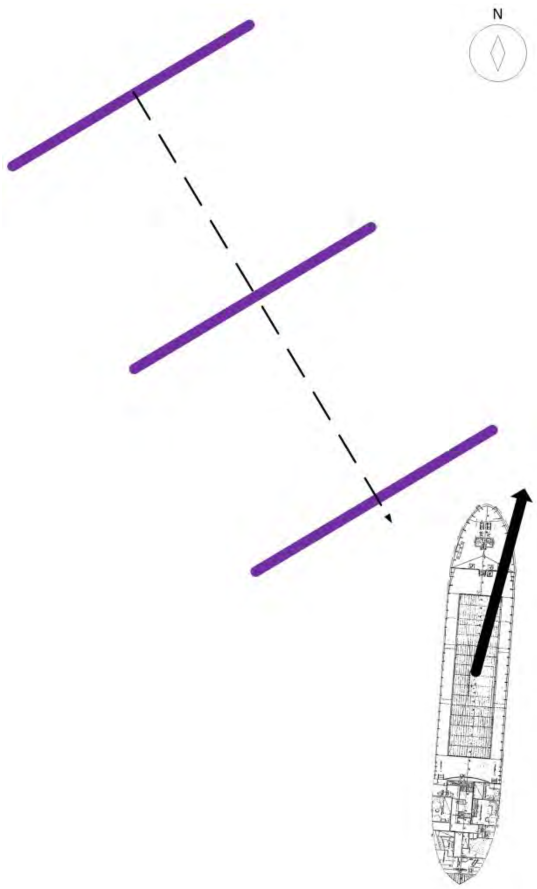


Figur 20:
Øverst venstre: Hastighet over grunn, kurs og kurs over grunn.
Øverst høyre: Beregnet gjennomsnittlig akselerasjon mellom to målepunkter, kurs og kurs over grunn.
Nederst venstre: Høyre strek angir Finnøyglimts seilas i tidsrommet over rasterkart. Fra AIS Utland
Nederst høyre: Tilsvarende som nederst venstre men med elektronisk kart.

2.17 Kl. 21:32:30 – 21:33:06 – Svenskaskjær - Ramnsholmene

Kl. 21:32:20 var fartøyet midt mellom Svenkaskjær. Mer presist var det 850 m vest for Svenkaskjær og 1000 m øst for Ramnsholmene. Posisjonen var N 59 30,69’ E 5 12,76’. Dette er 110 meter lenger nordøst enn siste registrerte målepunkt kl. 21:39:14. Det fremkommer ingen større utslag i akselerasjon omkring denne tiden, men i perioden mellom kl. 21:31:20 og 21:32:30 observeres en kursendring mot styrbord fra 4 til 15 grader før kursen er tilbake til 4 grader.

Omtrent kl. 21:32:30 påbegynte fartøyet babord sving. Kursen var da 4 grader, COG 15 grader og hastighet 5,7 knop.



Figur 21: Illustrasjon av fartøyets kurs, COG (svart heltrukken pil) og bølgenes retning kl. 21:32:30. Blå streker illustrerer vindsjøens bølgekam. Avstanden mellom bølgekammene er ikke proporsjonalt med fartøyets størrelse.

I løpet av 40 sekunder øker differansen mellom kurs og COG fra tilnærmet 0 til 28 grader. Deretter blir avviket mindre. Denne svingen varte frem til kl. 21:36:06. Da hadde fartøyet kurs 110. Dvs. en kursendring på 254 grader.

Fartøyet seilte over dybder på mer enn 300 meter.

Vest for fartøyet var Ramnsholmene. Lenger vest og nord for dette området (dvs. fra der fartøyet var kl. 21:23) lå Gåseskjærene. Nord for Gåseskjærene lå mange større holmer, skjær og grunner.

Nordvest for fartøyet var det fortsatt dybder på mer enn 300 meter. Dette var over en avstand på mer enn 700 meter. Nordvest for dette var dybdene 100 – 200 meter.

Øst før fartøyet var det mange holmer og skjær. I noen områder avtar dybden brått, men det er ingen større bredder av disse.

Nordøst for fartøyet var Langneset og Lakseklubben. Dette utgjør rett land i sydvest-nordøst retning over 500 meter. Vest for denne lengden endres dybden brått fra 50 til 0 meter over en lengde på omkring 100 meter. Endringen i dybden sammenfaller med retningen på vindsjøen.

Havarikommisjonens vurderinger:

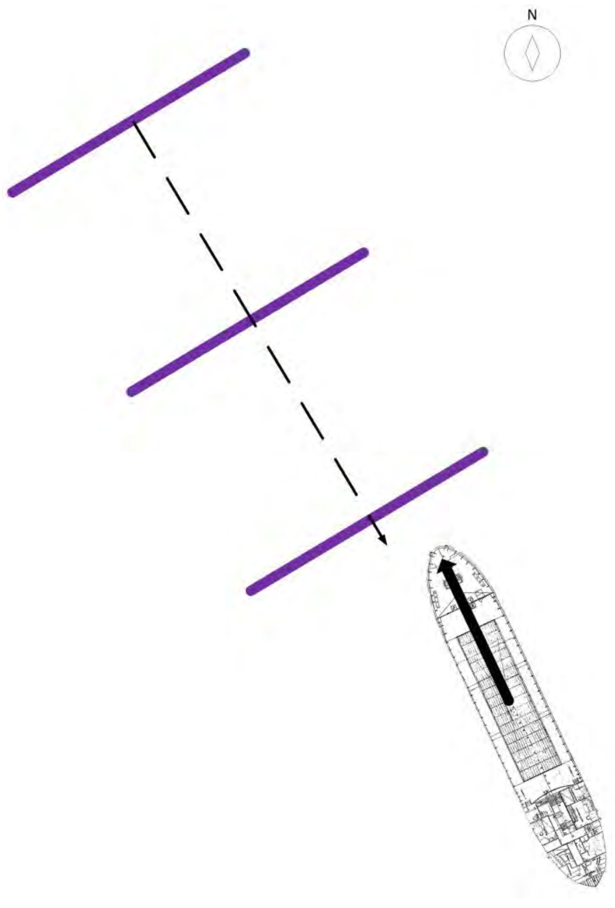
Området var antageligvis skjermet for dønningene fra vest slik som tidligere. Men etter at fartøyet kom på høyde med Ramnsholmene var det antageligvis lite som skjermet for vindsjøen fra nordøst. Sjøområdet i nordøstlig retning er åpent over nærmere 3 n.mil. Det vil si at vindsjøen vil kunne bygge opp sjø over denne strekningen. Det vil si at på dette tidspunktet fikk fartøyet en større vindsjø mot babord baug enn tidligere. Fartøyet var eksponert for disse sjøforholdene frem til forliset.

Det er også en mulighet for at vindsjø som kom mot brågrunnen langsmed Langeneset og Lakseklubben kan ha blitt reflektert. En stor del av disse bølgene kan ha blitt reflektert og kommet fra nordøst. Dermed er det en mulighet for at fartøyet kan ha blitt eksponert for vindsjøbølger fra nordvest samt reflekterte bølger fra nordøst. I et slikt tilfelle har bølgene blitt høyere og steilere. Det knyttes større usikkerhet til denne teorien.

Den brå kursendringen forstås ved at kursen ble lagt hardt babord, antageligvis en bevisst kommando av navigatøren. Det er mulig at det før dette ble forsøkt med en styrbord sving, men at dette ble omgjort til å heller velge en babord sving.

2.18 Kl. 21:33:16 Svenkaskjær - Ramnsholmene

Kl. 21:33.16 oppstod det en større akselerasjon på -0,051 m/s^2. På dette tidspunkt hadde fartøyet kurs 333 grader, COG 336 grader og hastighet 5 knop.



Figur 22 Illustrasjon av fartøyets kurs, COG (svart heltrukken pil) og bølgenes retning kl. 21:33:16. Blå streker illustrerer vindsjøens bølgekam. Avstanden mellom bølgekammene er ikke proporsjonalt med fartøyets størrelse.

Fartøyet var da 160 meter nordvest for posisjon kl. 21:32:30. Hastigheten hadde begynt å avta og kursen hadde begynt å dreie babord.

Havarikommisjonens vurderinger:

Det vurderes at de lokale holmer, skjær, samt grunner vest for Ramnsholmene, har tatt av for dønningene fra vest.

Det vurderes at det har vært liten vekselvirkning mellom vindsjøen og dybdeforholdene i forkant av eller ved der fartøyet var i dette tidsrommet.

Fartøyet ble eksponert for vindsjø fra nordvest (over dypt vann). Vindsjøen kom rett mot baugen.

Sammenlignet med vitneutsagnene til mannskapet og VHF-samtale med Kvitsøy VTS så virker det å sammenfalle med at omkring dette tidspunktet observerte mannskapet tre bunnslag.

Vi kan ikke forklare hvorfor ikke alle tre bunnslagene kan avleses fra AIS-dataene.

Dataserie fra tidsrommet 2129 til 2133.

Time	Hastighet over grunn (SOG)	Kurs over grunn (COG)	Kurs	Differanse mellom kurs og COG	Gj.snitt akselerasjon mellom to målepunkter
21:29:31	6,4	6	4	-2	0,000
21:29:40	6,3	5	3	-2	-0,006
21:29:51	6,3	5	3	-2	0,000
21:30:00	6,3	4	5	1	0,000
21:30:10	6,3	5	7	2	0,000
21:30:19	6,3	5	7	2	0,000
21:30:30	6,3	7	9	2	0,000
21:30:40	6,3	8	9	1	0,000
21:30:50	6,3	9	9	0	0,000
21:31:01	6,2	11	7	-4	-0,005
21:31:09	6,1	11	5	-6	-0,006
21:31:20	6,1	9	4	-5	0,000
21:31:31	6	6	8	2	-0,005
21:31:39	6	6	11	5	0,000
21:31:47	5,9	7	14	7	-0,006
21:31:51	5,9	9	15	6	0,000
21:31:55	5,9	10	15	5	0,000
21:31:58	5,9	11	15	4	0,000
21:32:02	5,8	12	15	3	-0,013
21:32:10	5,9	13	13	0	0,006
21:32:19	5,7	15	9	-6	-0,011
21:32:30	5,7	15	4	-11	0,000

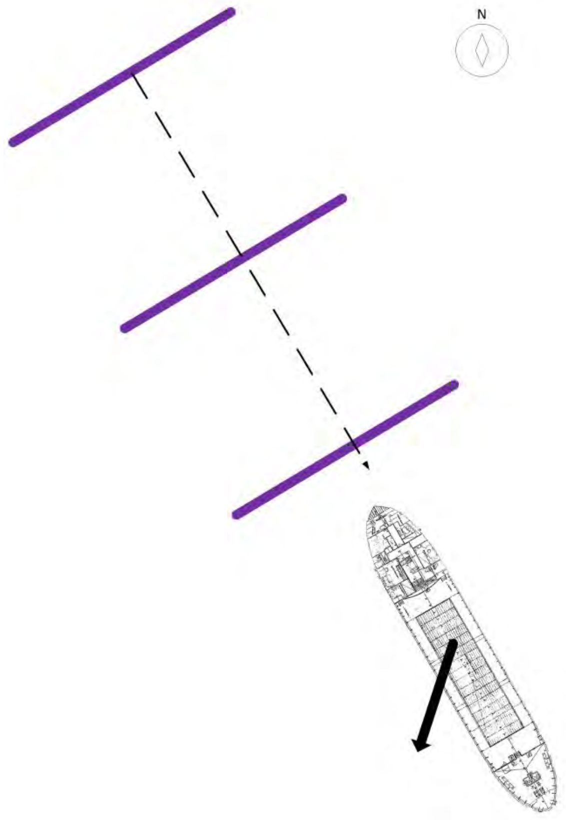
21:32:37	5,7	15	354	-21	0,000
21:32:40	5,6	12	352	-20	-0,017
21:32:45	5,5	10	343	-27	-0,010
21:32:46	5,5	9	342	-27	0,000
21:32:50	5,4	5	337	-28	-0,013
21:32:55	5,3	1	335	-26	-0,010
21:32:57	5,2	355	334	-21	-0,026
21:33:01	5,1	351	333	-18	-0,013
21:33:04	5,1	348	331	-17	0,000
21:33:08	5	343	331	-12	-0,013
21:33:09	5	342	332	-10	0,000
21:33:15	5,1	337	332	-5	0,009
21:33:16	5	336	333	-3	-0,051
21:33:19	5,1	334	333	-1	0,017
21:33:23	5,1	333	334	1	0,000

2.19 Kl. 21:35:19

På dette tidspunktet er det beregnet den største akselerasjonen. Den var på 0,103 m/s^2. Fartøyet dreide fortsatt hardt babord. Kursen var 150 grader, mens COG var 198. Hastigheten hadde avtatt til 4,1 knop. Det vil si at fartøyet pekte mot sydøst, mens fartøyet beveget seg mot syd.

Havarikommisjonens vurderinger:

På dette tidspunktet fikk fartøyet vindsjøen på låringen. Ved at bølgene kom mot låringen kan bølgene ha løftet akterskipet slik at baugen gikk ned.



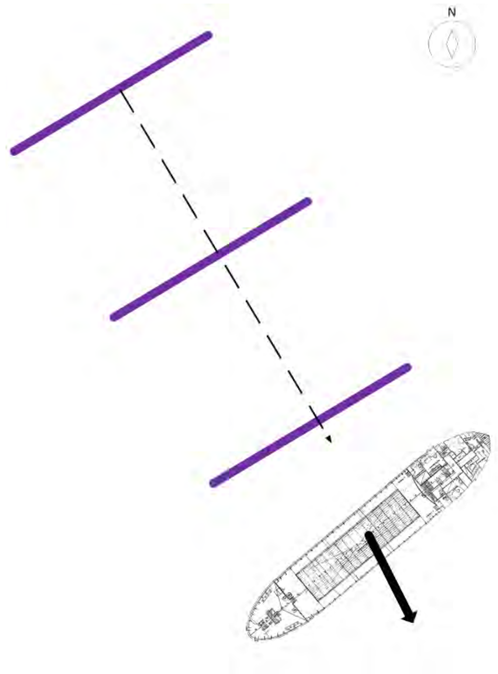
Figur 23: Illustrasjon av fartøyets kurs, COG (svart heltrukken pil) og bølgenes retning kl. 21:35:19. Blå streker illustrerer vindsjøens bølgekam. Avstanden mellom bølgekammene er ikke proporsjonalt med fartøyets størrelse.

2.20 Fire større akselerasjoner mellom kl. 21:36:56 og 21:37:30

De beregnede akselerasjonene viser fire akselerasjoner på -0,051 m/s^2 over et tidsrom på 34 sekunder. Tiden mellom hver av disse akselerasjonene var hhv 11, 12, 11 sekunder. Fartøyets hastighet avtok fra 5,3 til 3 knop. I dette tidsrommet dreide kursen fra 199 til 270 grader. Hastigheten avtok fra 5,3 til 3 knop. Fartøyet beveget seg på tvers mot syd.

Havarikommisjonens vurderinger:

Tiden mellom akselerasjonene sammenfaller med bølgeperioden til vindsjøen. I løpet av denne tiden, 34 sekunder, ble fartøyet dreid tvers av vind og vindsjø slik at vindsjøen slo mot styrbord side.



Figur 24: Illustrasjon av fartøyets kurs, COG (svart heltrukken pil) og bølgenes retning kl. 21:37:07. Blå streker illustrerer vindsjøens bølgekam. Avstanden mellom bølgekammene er ikke proporsjonalt med fartøyets størrelse.

Klokkeslett	Hastighet	Kurs over grunn (COG)	Kurs	Differanse mellom kursene	Gj. snitt akselerasjon
21:36:56	5,3	132	199	67	-0,051
21:37:02	5,1	138	215	77	-0,017
21:37:07	4,6	147	229	82	-0,051
21:37:10	4,5	151	236	85	-0,017
21:37:14	4,2	157	245	88	-0,039
21:37:18	3,9	161	249	88	-0,039
21:37:19	3,8	165	256	91	-0,051
21:37:25	3,4	171	260	89	-0,034
21:37:27	3,3	174	266	92	-0,026
21:37:30	3	179	270	91	-0,051

2.21 Etter kl. 21:37:30

Det var ingen (beregnede) akselerasjoner som oversteg 0,026 m/s^2 etter kl. 21:37:30. Fartøyet fortsatte å dreie styrbord.

2.22 Siste registrerte tidspunkt - kl. 21:39:14

Dette er siste registrerte tidspunkt.

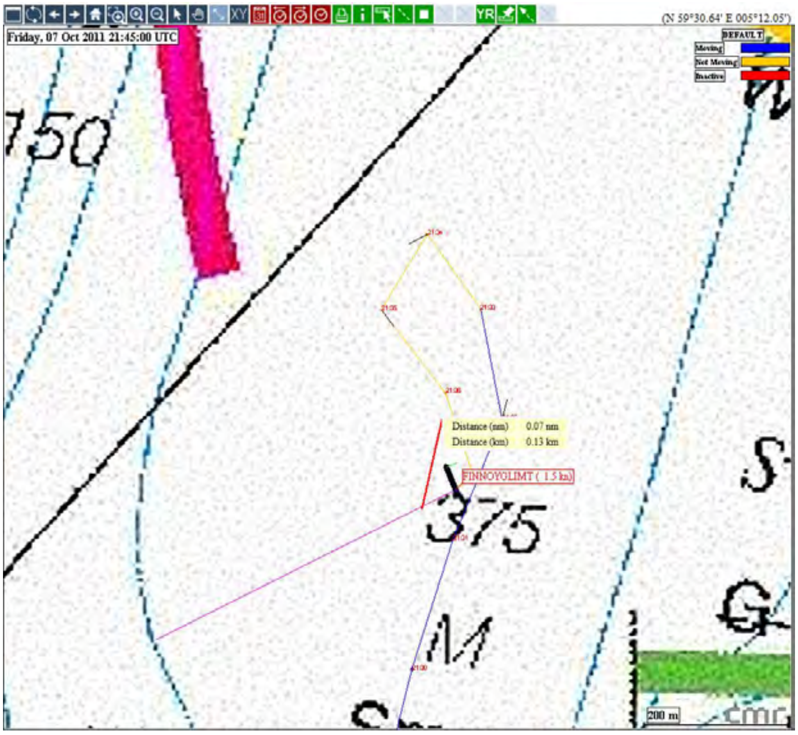
- Klokkeslettet for siste signal var: 21:39:14 UTC

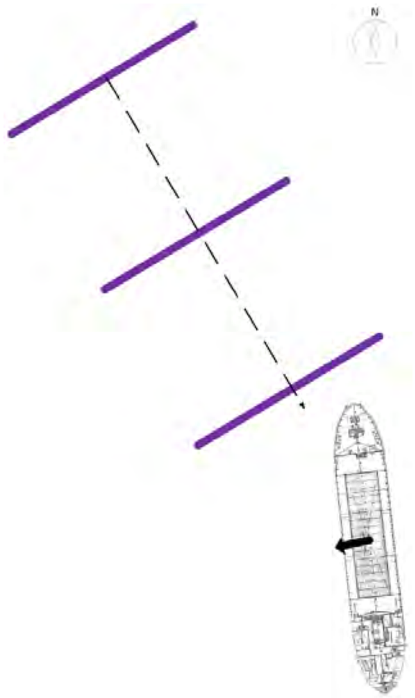
- Posisjon: N 59° 30,616’ Ø 5° 12,66’
- Hastighet (SOG): 0,9 knop
- Kurs: 355
- Kurs over grunn (COG): 258

I henhold til dataene som ble registrert i forbindelse med ROV-undersøkelsen etter forliset ligger Finnøyglimt i pos. N 59° 30,678’, Ø 005° 12,669’.

Det er godt samsvar mellom disse to posisjonene. Forskjellen mellom disse to posisjonene er at siste AIS-data er 130 meter syd-sydvest for den posisjonen er registrert å ligge, se rød strek på figur.

Det er godt samsvar mellom AIS fra Kystverketes netttjeneste og de behandlede dataene.





Figur 25: Illustrasjon av fartøyets kurs, COG (svart heltrukken pil) og bølgenes retning kl. 21:39:14. Blå streker illustrerer vindsjøens bølgekam. Avstanden mellom bølgekammene er ikke proporsjonalt med fartøyets størrelse.

2.23 Dataserie for kl. 21:32:30 – 21:39:14

Bredde-grad	Lengde-grad	Tidspunkt	Hastighet [knop]	Kurs over grunn (COG)	Kurs	Differanse mellom kursene	Gj.snitt akselerasjon
59,511445	5,2125967	21:32:30	5,7	15	4	-11	0,000
59,5115933	5,212675	21:32:37	5,7	15	354	-21	0,000
59,5116633	5,2126533	21:32:40	5,6	12	352	-20	-0,017
59,5117867	5,2126633	21:32:45	5,5	10	343	-27	-0,010
59,5118433	5,2126667	21:32:46	5,5	9	342	-27	0,000
59,511935	5,2126283	21:32:50	5,4	5	337	-28	-0,013
59,512005	5,2125767	21:32:55	5,3	1	335	-26	-0,010
59,5120933	5,2125	21:32:57	5,2	355	334	-21	-0,026
59,5121517	5,212435	21:33:01	5,1	351	333	-18	-0,013
59,5122167	5,2123783	21:33:04	5,1	348	331	-17	0,000
59,512295	5,2122683	21:33:08	5	343	331	-12	-0,013
59,5123283	5,212235	21:33:09	5	342	332	-10	0,000
59,5124383	5,2120917	21:33:15	5,1	337	332	-5	0,009
59,5124683	5,2120467	21:33:16	5	336	333	-3	-0,051
59,5125367	5,2119683	21:33:19	5,1	334	333	-1	0,017
59,512595	5,211885	21:33:23	5,1	333	334	1	0,000
59,5126983	5,2117483	21:33:27	5,2	331	336	5	0,013
59,5127583	5,2116733	21:33:31	5,2	330	338	8	0,000
59,5129483	5,2114783	21:33:39	5,2	330	341	11	0,000
59,5131233	5,2113167	21:33:47	5,2	333	335	2	0,000
59,5131867	5,21129	21:33:50	5,1	332	332	0	-0,017

59,513235	5,2112667	21:33:54	5,1	336	326	-10	0,000
59,5133133	5,211205	21:33:57	5	336	317	-19	-0,017
59,5133883	5,2111167	21:34:02	4,9	336	304	-32	-0,010
59,5134467	5,2110633	21:34:03	4,9	336	296	-40	0,000
59,5135267	5,21088	21:34:10	4,6	329	281	-48	-0,022
59,5135667	5,2106983	21:34:14	4,4	321	268	-53	-0,026
59,513585	5,2106383	21:34:17	4,3	318	263	-55	-0,017
59,5135833	5,21052	21:34:20	4,1	311	257	-54	-0,034
59,5135933	5,2103717	21:34:24	4	307	251	-56	-0,013
59,513585	5,2102267	21:34:28	3,8	296	239	-57	-0,026
59,5135783	5,2101267	21:34:30	3,7	289	233	-56	-0,026
59,5135583	5,21002	21:34:33	3,7	282	228	-54	0,000
59,51353	5,2099217	21:34:37	3,6	275	221	-54	-0,013
59,5135	5,209825	21:34:40	3,6	269	217	-52	0,000
59,5134683	5,20973	21:34:43	3,6	262	208	-54	0,000
59,5134133	5,2096183	21:34:47	3,6	254	202	-52	0,000
59,513355	5,2095267	21:34:51	3,6	247	195	-52	0,000
59,5132917	5,2094183	21:34:55	3,7	240	189	-51	0,013
59,5132383	5,209375	21:34:57	3,7	232	182	-50	0,000
59,5131833	5,209315	21:35:01	3,8	228	179	-49	0,013
59,513125	5,20931	21:35:04	3,7	220	172	-48	-0,017
59,5130467	5,20922	21:35:07	3,9	217	169	-48	0,034
59,5130017	5,2092433	21:35:10	3,8	211	165	-46	-0,017
59,51291	5,2091733	21:35:15	4	207	158	-49	0,021
59,51286	5,2091917	21:35:18	3,9	201	153	-48	-0,017
59,5127917	5,20918	21:35:19	4,1	198	150	-48	0,103
59,51265	5,20924	21:35:27	4,1	189	141	-48	0,000
59,5125667	5,209285	21:35:30	4,2	182	135	-47	0,017
59,51251	5,2093217	21:35:34	4,1	177	132	-45	-0,013
59,5124383	5,20942	21:35:38	4,1	170	130	-40	0,000
59,512395	5,2094483	21:35:39	4,1	168	128	-40	0,000
59,5123383	5,2095033	21:35:42	4,2	166	126	-40	0,017
59,5122683	5,2096083	21:35:46	4,2	160	123	-37	0,000
59,512195	5,2097	21:35:50	4,2	156	120	-36	0,000
59,5121517	5,209785	21:35:54	4,3	153	116	-37	0,013
59,5120783	5,2099083	21:35:57	4,4	149	114	-35	0,017
59,5120467	5,2100067	21:36:01	4,4	145	112	-33	0,000
59,5120033	5,2100583	21:36:02	4,4	145	112	-33	0,000
59,5119567	5,21021	21:36:06	4,4	139	110	-29	0,000
59,5119133	5,2103167	21:36:09	4,5	137	112	-25	0,017
59,511885	5,21043	21:36:13	4,5	133	111	-22	0,000
59,5118317	5,210575	21:36:17	4,5	133	113	-20	0,000
59,511795	5,21069	21:36:20	4,6	128	115	-13	0,017
59,5117567	5,210855	21:36:24	4,6	126	119	-7	0,000
59,5117133	5,2109717	21:36:28	4,7	125	121	-4	0,013

59,51167	5,211135	21:36:31	4,8	123	127	4	0,017
59,5116367	5,211275	21:36:33	4,9	122	131	9	0,026
59,511585	5,211445	21:36:37	5	121	142	21	0,013
59,5115483	5,2115167	21:36:40	5,1	122	144	22	0,017
59,511465	5,2117283	21:36:44	5,2	122	159	37	0,013
59,5114317	5,2118133	21:36:48	5,3	124	168	44	0,013
59,5112933	5,2120533	21:36:55	5,4	129	193	64	0,007
59,5112267	5,2120917	21:36:56	5,3	132	199	67	-0,051
59,5111517	5,21216	21:37:02	5,1	138	215	77	-0,017
59,5110183	5,21222	21:37:07	4,6	147	229	82	-0,051
59,5109817	5,2121967	21:37:10	4,5	151	236	85	-0,017
59,51091	5,2122067	21:37:14	4,2	157	245	88	-0,039
59,5108483	5,212185	21:37:18	3,9	161	249	88	-0,039
59,5108133	5,2121733	21:37:19	3,8	165	256	91	-0,051
59,5107667	5,212125	21:37:25	3,4	171	260	89	-0,034
59,51073	5,2121183	21:37:27	3,3	174	266	92	-0,026
59,5107	5,2120917	21:37:30	3	179	270	91	-0,051
59,5106533	5,2120567	21:37:34	3	182	274	92	0,000
59,5106133	5,212015	21:37:38	2,8	187	280	93	-0,026
59,510585	5,2119917	21:37:39	2,8	190	281	91	0,000
59,510535	5,21192	21:37:45	2,6	196	286	90	-0,017
59,5104833	5,211825	21:37:53	2,2	204	295	91	-0,026
59,5104417	5,2117867	21:37:57	2,3	207	297	90	0,013
59,510455	5,2117683	21:38:01	2,1	211	301	90	-0,026
59,510405	5,21169	21:38:02	2,1	212	304	92	0,000
59,5104267	5,2116633	21:38:06	1,9	217	306	89	-0,026
59,510395	5,2116133	21:38:09	2	219	310	91	0,017
59,51034	5,21153	21:38:13	1,9	222	312	90	-0,013
59,51034	5,2115017	21:38:17	1,8	225	317	92	-0,013
59,51032	5,2114433	21:38:20	1,8	227	319	92	0,000
59,5103233	5,21143	21:38:24	1,6	231	324	93	-0,026
59,5103183	5,2113917	21:38:28	1,6	232	325	93	0,000
59,5102983	5,2113417	21:38:31	1,5	235	329	94	-0,017
59,5102983	5,2113217	21:38:33	1,5	238	330	92	0,000
59,5102917	5,2112867	21:38:37	1,5	240	334	94	0,000
59,51029	5,2112667	21:38:40	1,4	242	334	92	-0,017
59,5102867	5,2111983	21:38:44	1,3	245	339	94	-0,013
59,5102817	5,2111717	21:38:47	1,3	249	342	93	0,000
59,5102767	5,2111033	21:38:55	1,2	252	346	94	-0,006
59,5102783	5,2110833	21:38:56	1,2	255	348	93	0,000
59,5102733	5,2110533	21:39:02	1,1	257	349	92	-0,009
59,5102667	5,2110117	21:39:04	1,1	258	352	94	0,000
59,5102617	5,21098	21:39:10	0,9	258	355	97	-0,017
59,5102617	5,21098	21:39:14	0,9	258	355	97	0,000

SBF2014F0016 - Restricted

Rapport

Lasteskipet Finnøyglimt.

Bestemmelse av materialparametre for fraktet bulkmateriale.

Forfatter(e)
Jan Ove Busklein

SINTEF Byggforsk
Infrastruktur
2014-03-02

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Rapport

Lasteskipet Finnøyglimt.

Bestemmelse av materialparametre for fraktet bulkmateriale.

EMNEORD:
geoteknikk; stabilitet

VERSJON
2.0

DATO
2014-03-02

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OPPDRAGSGIVER(E)
Statens Havarikommisjon for Transport

OPPDRAGSGIVERS REF.
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ANTALL SIDER OG VEDLEGG:
8+ vedlegg

SAMMENDRAG

Den 7. oktober 2011 forliste lasteskipet Finnøyglimt da det fraktet sand og singel i bulk. Statens havarikommisjon for transport, SHT, har i den forbindelse engasjert SINTEF til å foreta noen laboratorieundersøkelser av materialene som ble fraktet. De viktigste funnene er en Transport Moisture Limit på 10,4 % for sanda og at tørrdensiteten avviker fra tørrdensiteten oppgitt av leverandøren. Friksjonsvinkelen til sanda er lavere enn rasvinkelen noe som kan medføre at sanda omstrukturerer seg ved tilførsel av energi som ved stamping og rulling av skipet.

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RAPPORTNR	ISBN	GRADERING	GRADERING DENNE SIDE
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Historikk

VERSJON	DATO	VERSJONSBESKRIVELSE
1.0	2014-01-20	Rapport
2.0	2014-02-26	Rapport. Forklaring på bruddflate lagt til.

Innholdsfortegnelse

BILAG/VEDLEGG

Datarapport NTNU Geoteknikk

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1 Bakgrunn

Den 7. oktober 2011 forliste lasteskipet Finnøyglimt da det fraktet sand og singel i bulk. Statens havarikommisjon for transport, SHT, gjennomfører i den forbindelse en sikkerhetsundersøkelse av forliset for å kartlegge hendelsesforløpet og årsaker med den hensikt å forhindre tilsvarende ulykker i fremtiden.

2 Oppdrag

I forbindelse med SHTs sikkerhetsundersøkelse av forliset er SINTEF engasjert for å foreta laboratorieundersøkelser av materialene som ble fraktet i den hensikt å kartlegge hvorvidt disse har egenskaper til å forskyve seg. Skipet var lastet med 0-8 mm sand og 8-16 mm grus.

3 Laboratorieforsøk

International Marine Organization har utarbeidet en " Code of safe practice for solid bulk cargoes", også kalt "BC code". Her omtales ulike forhold ved bulkmaterialer som man skal ta hensyn til, blant annet Transportable Moisture Limit, TML, og angle of repose, rasvinkelen. I tillegg har SHT bedt SINTEF om å måle korndensitet og tørrdensitet til materialene og å beregne materialenes porøsitet.

Kartlegging av materialegenskapene er foretatt ved flere laboratorier ved SINTEF/NTNU: TML og vanninnhold for sand og rasvinkel for sand og grus er målt i SINTEFs betonglaboratorium. Korndensitet, tørrdensitet og friksjonsvinkel for sand er målt av NTNU Geoteknikk. Vanninnhold og korndensitet for grus er målt i NTNU Geoteknikk sitt laboratorium av SINTEF. I tillegg har NTNU Geoteknikk foretatt kornfordelingsanalyse av begge materialene. Tester utført av NTNU Geoteknikk er rapportert i vedlegg A.

SINTEF mottok den 13. november to sekker med materialprøver fra NCC Roads AS, en sekk med 0-8N sand og en sekk med 8-16N grus. Bulkdensiteten er av NCC Roads AS oppgitt til å være 1500 kg/m3 for 0-8N sand og 1400 kg/m3 for 8-16N grus. Lastehøyden for sanden er av Statens Havarikommisjon for transport oppgitt til å være 4,015 meter.

3.1 Flow Moisture Point, Fallbordtest

Materialer med finstoff kan bli tyntflytende når fuktinnholdet er høyt nok og materialet utsettes for støt. Dette fuktinnholdet kalles Flow Moisture Point, FMP, og kan bestemmes ved blant annet fallbordtesten. Transportable Moisture Limit, TML, er i BC Code satt til 90 % av FMP.

Sandprøven ble prøvd i henhold til Code of Safe Practice for Bulk Cargoes, 1998 Edition, Appendix D den 29. november i SINTEFs betonglaboratorium.

Prøvingen ble utført etter følgende prosedyre:

- Utsplitting av 3 kg representativ prøve
- Deling av denne prøven i 5 deler, hvorav
- A: 1/5 ble tatt ut til bestemmelse av fuktinnhold ved ankomst
- B: 2/5 ble tatt ut til orienterende bestemmelse av FMP (Flow Moisture Content)
- C: 2/5 ble tatt ut til endelig bestemmelse av FMP

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Prøve tatt ut til bestemmelse av fuktinnhold ved ankomst ble tørket ved 105 ºC til konstant vekt.

Resultat
Fuktinnhold ved ankomst: w = 5,4 % av tørrvekt

Bestemmelse av FMP

Utstyr
Fallbord med konus i henhold til ASTM C230.
Fjærbelastet stamper (Ø30 mm) med indikasjon av påført komprimeringstrykk i kPa.

Komprimeringstrykk på stamper
Komprimeringstrykket på stamperen var:
Trykk (Pa) = Bulk densitet (kg/m^3) x Maksimum lastedybde (m) x g (m/s^2)
Trykk = 1500 x 4,015 x 9,81 Pa ≈ 60 kPa

Orienterende bestemmelse av FMP
Prøve B ble anvendt til innledende prøving. Prøven ble stegvis tilsatt vann, ca 10 ml per steg. Etter hver vanntilsetning ble det foretatt prøving på fallbordet. Konusen ble fylt i 3 lag, hvorav det første laget ble komprimert med 30 stikk, det andre med 25 og det siste laget med 20 stikk med stamperen. Konusen ble fjernet og prøven ble gitt 10-15 slag på fallbordet. Prøven som viste tilnærmet plastisk deformasjon ble veid til konstant vekt for bestemmelse av innledende TMP

Resultat
Innledende TMP: 11,6 %

Endelig bestemmelse av FMP og TML
Prøve C ble anvendt til bestemmelse av endelig FMP. Prøven ble innledningsvis tilsatt vann til ca. 10,0 % av tørrvekt. Deretter ble vanninnholdet stegvis øket med ca. 0,4 %. Dette ble oppnådd ved at etter hvert steg ble prøven fra fallbordet (ca. 0,5 kg) tatt vare på i lukket beholder, mens prøven fra forrige forsøk (ca. 0,5 kg) ble blandet med gjenværende masse (ca. 0,2 kg) før tilsetning av 4,5 g vann.
Etter at plastisk oppførsel ble oppnådd ble vanninnholdet bestemt for den siste prøven fra fallbordet og den nest siste som var oppbevart i lukket beholder. Den siste prøven viste plastisk deformasjon med 10 mm utbredelse etter 25 slag på fallbordet. Den nest siste prøven viste noe plastisk deformasjon, men den sprakk før 25 slag på fallbordet.
FMP er middelverdien av disse to forsøkene. TML (Transport Moisture Limit) er 90 % av FMP.

Resultat
Vanninnhold for nest siste prøve: 11,2 %
Vanninnhold for siste prøve: 11,7 %
FMP: 11,5 %
TML: 10,4 %

3.2 Treaksialtest

Sanda ble tilsatt vann til et vanninnhold tilnærmet lik TML var oppnådd. Det ble deretter bygget inn to prøver som det ble kjørt treaksialtest på for å finne friksjonsvinkelen. Celletrykket for prøvene ble satt til

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henholdsvis 40 kPa og 25 kPa. Friksjonsvinkelen for sanda ble funnet å være 42,5 grader med en antatt attraksjon lik 0. Utskrift av treaksialtestene finnes i vedlegg A.

Friksjonsmaterialer som sand og grus vil også gå til brudd når de indre spenningene blir for store. Det dannes da et skjærplan som materialet vil skli langs. Dette er ikke omtalt i BC code, men er tatt med for å kunne si litt mer om materialenes egenskaper.

Hvor store indre spenninger et jordmateriale tåler bestemmes av jordpartiklenes inngripen i hverandre og dermed deres motstand mot å gli i forhold til hverandre. I friksjonsmasser gjelder effektivspenningsprinsippet. Dette prinsippet kan forklares ved:

Effektivspenning = totalspenning - poretrykk

Finstoff i massen kan antas å ha blitt transportert nedover i lasten over tid på grunn av bevegelser i skipet. Ved rulling og stamping kan det bygges opp et poreovertrykk i den finstoffholdige delen av massen. Dette vil føre til at den finstoffholdige massen kan nærme seg bruddtilstanden.

Hvis jordpartiklene presses fra hverandre, som ved økt poretrykk, vil effektivspenningen reduseres. I slike tilfeller kan materialets egenvekt være nok til at styrken overskrides. Det er oppgitt at lasten er trimmet horisontalt. Hvis skipet ruller er lastens overflate ikke lenger horisontal, men vil bevege seg i forhold til horisontalplanet. Man får da i realiteten en skråning. Hvis materialets styrke i et område blir redusert på grunn av økt poretrykk, for eksempel ved liquifaction, kan lasten, på grunn av egenvekten og/eller tilført energi fra stamping, plutselig skli langs en bruddflate i dette området og forsøke å innstille seg tilnærmet horisontalt.

3.3 Rasvinkel

Rasvinkelen er den vinkelen materialet vil stå i uten at partiklene på overflaten sklir ned langs overflaten av materialet, for eksempel når man heller materialet slik at det danner en kjegle.

Rasvinkelen er bestemt i henhold til prosedyren beskrevet i BC code, appendiks D 2.2. og ble utført den 21. november i SINTEFs betonglaboratorium. Ca 2 liter av materialet ble helt ut på et horisontalt bord slik at det dannet en kjegle. Nytt materiale ble deretter helt på toppen av kjeglen slik at dette fordelte seg ned langs overflaten av kjeglen. Deretter ble vinkelen mellom horisontalplanet og sidekanten til kjeglen målt på fire steder rundt kjeglen med et vater med dreibar libelle med gradestreker. Det ble målt rasvinkel på tre kjegler og resultatene for de to materialene er vist i Tabell 1og Tabell 2. Gjennomsnittlig rasvinkel ble så omregnet i henhold til BC code til rasvinkel i tilting box ved å legge til 3 grader.

Målested Prøve	1	2	3	4	Gjennomsnittlig rasvinkel
1	36	40	38	36	37,5
2	36	30	40	40	36,5
3	40	38	44	40	40,5
Gjenomsnitt alle prøver					38,0

Tabell 1 Grus 8-16N Rasvinkel målt på kjegle.

Resultat:
Rasvinkel etter tilting box for grus 8-16N er 38,0 + 3,0 = 41,0 grader.

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Målested Prøve	1	2	3	4	Gjennomsnittlig rasvinkel
1	52	56	50	50	52,0
2	52	54	50	50	51,5
3	54	54	54	50	53,0
Gjenomsnitt alle prøver					52,0

Tabell 2 Sand 0-8N Rasvinkel målt på kjegle.

Resultat:
Rasvinkel etter tilting box for sand 0-8N er 52,0 + 3,0 = 55,0 grader.

4 Densitet

Det er målt to densiteter for materialene, korndensitet og tørrdensitet. Korndensitet er massen av det tørre, faste stoffet dividert med volumet til det faste stoffet.

$$\rho_s = \frac{m_s}{V_s}$$

Tørrdensitet er massen av det tørre, faste stoffet dividert med prøvens totale volum, dvs. volumet til det faste stoffet og volum porer.

$$\rho_d = \frac{m_s}{V}$$

Materiale	**Korndensitet, ρ_s**	**Tørrdensitet, ρ_d**
Sand 0-8N	2,63	1,75
Grus 8-16N	2,65	1,5

5 Porøsitet og permeabilitet

Porøsiteten angir hvor stor andel av et materiales volum som er porer. Disse porene kan være fylt med luft og/eller vann. Et materiales porøsitet kan beregnes når materialets korndensitet og tørrdensitet er kjent etter følgende formel

$$n = \frac{\rho_s - \rho_d}{\rho_s}$$

Porøsitet sand: $n = \frac{2,63 - 1,75}{2,63} = 0,33$

Porøsitet grus: $n = \frac{2,65 - 1,5}{2,65} = 0,43$

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Permeabiliteten av materialet kan finnes som

$$k = C_1 \cdot d_{10}^2$$

hvor C_1=100 og d_{10} er effektiv korndiameter i centimeter som tilsvarer 10 % gjennomfall i en siktekurve. Permeabiliteten kan gi et bilde av hvor rask transporten av vann er mellom kornene.
De mottatte materialene ble siktet og materialenes kornfordelingskurver tegnet opp, se vedlegg A. Materialenes d_{10} ble så tatt ut av kurvene for å beregne materialenes permeabilitet.

	d_{10}	Permeabilitet, k
Sand 0-8N	0,015 cm	$2{,}25 \cdot 10^{-2}$ cm/sek
Grus 8-16N	0,61 cm	37 cm/sek

6 Oppsummering

På bakgrunn av laboratorieforsøk utført ved SINTEF Byggforsk kan materialparametere summeres slik:

	Sand 0-8N	Grus 8-16N
Tørrdensitet, ρ_d (oppgitt av leverandør)	1,5	1,4
Tørrdensitet, ρ_d	1,75	1,5
Korndensitet, ρ_s	2,63	2,65
Rasvinkel	55,0 grader	41,0 grader
Friksjonsvinkel	42,5 grader	-
Porøsitet, n	0,33	0,43
Permeabilitet, k	$2{,}25 \cdot 10^{-2}$ cm/sek	37 cm/sek
Målt fuktinnhold, w	5,4 % av tørr vekt	0,8 % av tørr vekt
Transport Moisture Limit, TML	10,4 % av tørr vekt	-

Rasvinkelen funnet med BC code (appendiks D 2.2) vil alltid være større enn friksjonsvinkelen funnet fra treaksialforsøk. Ved lasting av båt ved kai kan denne rasvinkelen oppnås, men ved seiling er båten utsatt for langsgående og sidegående bevegelser (stamping og rulling) forårsaket av bølgevirksomhet. Massen vil derfor ikke kunne stå med den målte rasvinkelen over tid og vil innstille seg i en lavere vinkel. For stabilitetsberegninger skal derfor friksjonsvinkelen funnet fra treaksialforsøk brukes.

Hvis materialets styrke i et område blir redusert på grunn av økt poretrykk, for eksempel ved liquifaction, kan lasten plutselig skli langs en bruddflate med lavere styrke enn friksjonsvinkelen i dette området.

Det må påpekes at tørrdensitet for sand oppgitt av leverandøren er benyttet for bestemmelse av TML da måling av tørrdensitet for materialene ikke ble en del av oppdraget før etter bestemmelse av TML var foretatt. Forskjellen i oppgitt og målt tørrdensitet vil imidlertid etter vår mening ikke ha stor påvirkning av TML.

Vedlegg A Datarapport NTNU Geoteknikk

NTNU Institutt for bygg, anlegg og transport
Faggruppe for Geoteknikk

Grunnundersøkelser Datarapport

Oppdrag: **Sand**
Dato: 19.12.2013

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Grunnundersøkelser

Datarapport

Oppdrag:	**Sand**
Dato:	19.12.2013
Oppdragsnr.	2013-30
Oppdragsgiver:	SINTEF GEOTEKNIKK
Prosjektnr.	
Kontaktperson:	JAN OVE BUSKLEIN

Saksbehandler: HELENE A. KORNBREKKE
E-post: HELENE.KORNBREKKE@NTNU.NO
Telefon: 994 34 608

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Innhold

Tegningsliste

Tegning nr.	Hull nr.	Laboratorieundersøkelse	Dybde [m]
1	-	Korndensitet	
2	-	Bulk densitet	
3	-	Kornfordelinger	
4	-	CIUC	
5	-	CIUC	

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Innledning

På oppdrag fra Sintef Geoteknikk har NTNU utført laboratorieundersøkelser på 2 poseprøver.

	Borehull nr.	Utførte undersøkelser
Poseprøver	-	2 kornfodelinger 1 korndensitet 1 Bulk densitet 2 CIDC

Resultatene ligger vedlagt.

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PRØVEÅPNING, Poseprøve

Borested:		Dato, prøvetaking		Masse av prøve	g
Hull nr.		Dato, prøveåpning		Volum av prøve	cm^3
Prøve nr.	0-8	Lengde av prøve	cm	Midlere densitet	g/cm^3
Dybde, z	- m	Masse av sylinder m/prøve	g	Tyngdetetthet	kN/m^3
Grunnvannstand	m	Masse av tom sylinder	g		

GENERELL KLASSIFISERING

Geologisk betegnelse:	Jordart: **Sand**
Beskrivelse:	Merknader:

VANNINNHOLD

	w_1	w_2	w_3	w_L	w_P
Skål nr.					
Total masse våt, g					
Total masse tørr, g					
Masse skål, g					
Masse vann, g					
Masse tørr prøve, g					
Vanninnhold, %					
Middelverdi vanninnhold (prøve 1,2,3):					

DENSITET LITEN PRØVE

	Ring	Skål
Ring/skål nr.		
Tot. masse våt, g		--------------
Tot. masse tørr, g	--------------	
Masse ring/skål, g		
Masse våt prøve, g		--------------
Masse tørr prøve, g	--------------	
Volum, cm^3		--------------
Densitet ρ, g/cm^3		

KONUSFORSØK / **ENAKS. TRYKK FORSØK**

Prøve	s_u	s_r	S_t	Prøve	s_u	ε
nr	kPa	kPa		nr	kPa	%
				1	0,0	

KORNDENSITET FRA PYKNOMETERMÅLING

Pyknometer nr.	
Masse pyknometer + vann, g	148,35
Masse pykn.+ prøve + vann, g	168,88
Total masse tørr, g	244,63
Skål nr.	
Masse skål, g	211,5
Masse tørr, g	33,13
Korndensitet ρ_s, g/cm^3	2,63

OPPSUMMERING OG RUTINEPARAMETRE

Densitet ρ		g/cm3
Korndensitet ρ_s	2,63	g/cm3
Vanninnhold w		%
Porøsitet n		%
Poretall e		
Metningsgrad S_r		%
Saltinnhold S		g/l
Humusinnhold		%
Plastisitetsindeks I_P		%
Flyteindeks I_L		-
s_u (Konus)		kPa
s_u (Enaks)	0,00	kPa
Sensitivitet S_t		

OPPDELING AV PRØVEN

Fra - Til (m)		Forsøk/Kommentarer
0,00		

Sand

Rutineundersøkelser, 54mm stålsylinder

NTNU Geoteknikk

Hull nr. -	Tegnet HAK	Godkjent JJO	Revidert
Dybde	Dato 19.12.2013	Oppdrags nr. 2013-30	Tegning nr. 1

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PRØVEÅPNING, Poseprøve

Borested:		Dato, prøvetaking		Masse av prøve	g
Hull nr.		Dato, prøveåpning		Volum av prøve	cm^3
Prøve nr.	**8-16mm**	Lengde av prøve	cm	Midlere densitet	g/cm^3
Dybde, z	- m	Masse av sylinder m/prøve	g	Tyngdetetthet	kN/m^3
Grunnvannstand	m	Masse av tom sylinder	g		

GENERELL KLASSIFISERING

Geologisk betegnelse:	Jordart: **Grus**
Beskrivelse: **Bulk densitet: 1.5 g/cm3**	Merknader:

VANNINNHOLD

	w_1	w_2	w_3	w_L	w_P
Skål nr.					
Total masse våt, g					
Total masse tørr, g					
Masse skål, g					
Masse vann, g					
Masse tørr prøve, g					
Vanninnhold, %					
Middelverdi vanninnhold (prøve 1,2,3):					

DENSITET LITEN PRØVE

	Ring	Skål
Ring/skål nr.		
Tot. masse våt, g		--------------
Tot. masse tørr, g	--------------	
Masse ring/skål, g		
Masse våt prøve, g		--------------
Masse tørr prøve, g	--------------	
Volum, cm^3		--------------
Densitet ρ, g/cm^3		

KONUSFORSØK

Prøve	s_u	s_r	S_t
nr	kPa	kPa	

ENAKS. TRYKK FORSØK

Prøve	s_u	ε
nr	kPa	%

KORNDENSITET FRA PYKNOMETERMÅLING

Pyknometer nr.	
Masse pyknometer + vann, g	
Masse pykn.+ prøve + vann, g	
Total masse tørr, g	
Skål nr.	
Masse skål, g	
Masse tørr, g	
Korndensitet ρ_s, g/cm^3	

OPPSUMMERING OG RUTINEPARAMETRE

Densitet ρ	g/cm3
Korndensitet ρ_s	g/cm3
Vanninnhold w	%
Porøsitet n	%
Poretall e	
Metningsgrad S_r	%
Saltinnhold S	g/l
Humusinnhold	%
Plastisitetsindeks I_P	%
Flyteindeks I_L	-
s_u (Konus)	kPa
s_u (Enaks)	kPa
Sensitivitet S_t	

OPPDELING AV PRØVEN

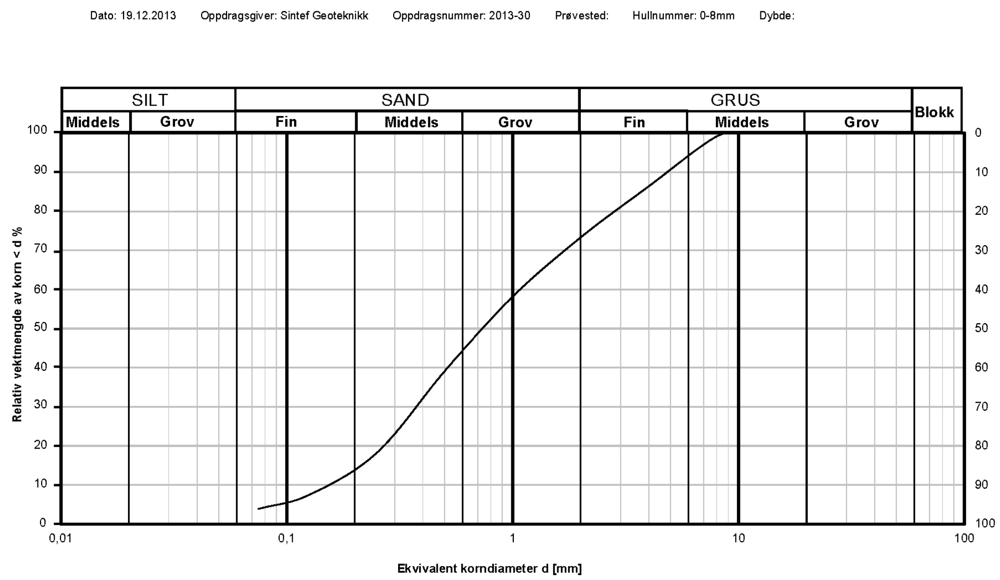
Fra	- Til (m)	Forsøk/Kommentarer
0,00		

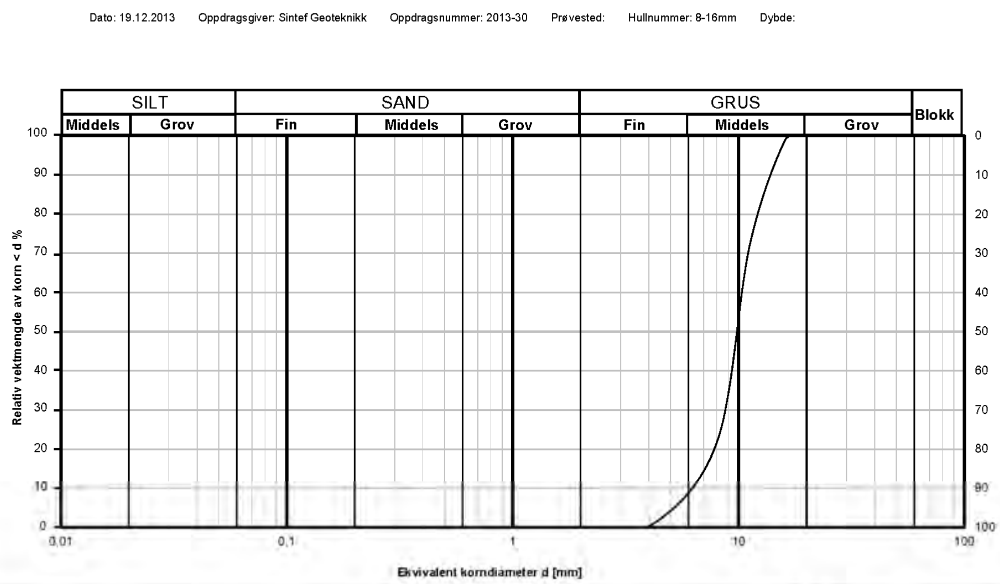
Sand

Rutineundersøkelser, 54mm stålsylinder

NTNU Geoteknikk

Hull nr. -	Tegnet HAK	Godkjent JJO	Revidert
Dybde 2.0-3.0m	Dato 19.12.2013	Oppdrags nr. 2013-30	Tegning nr. 2





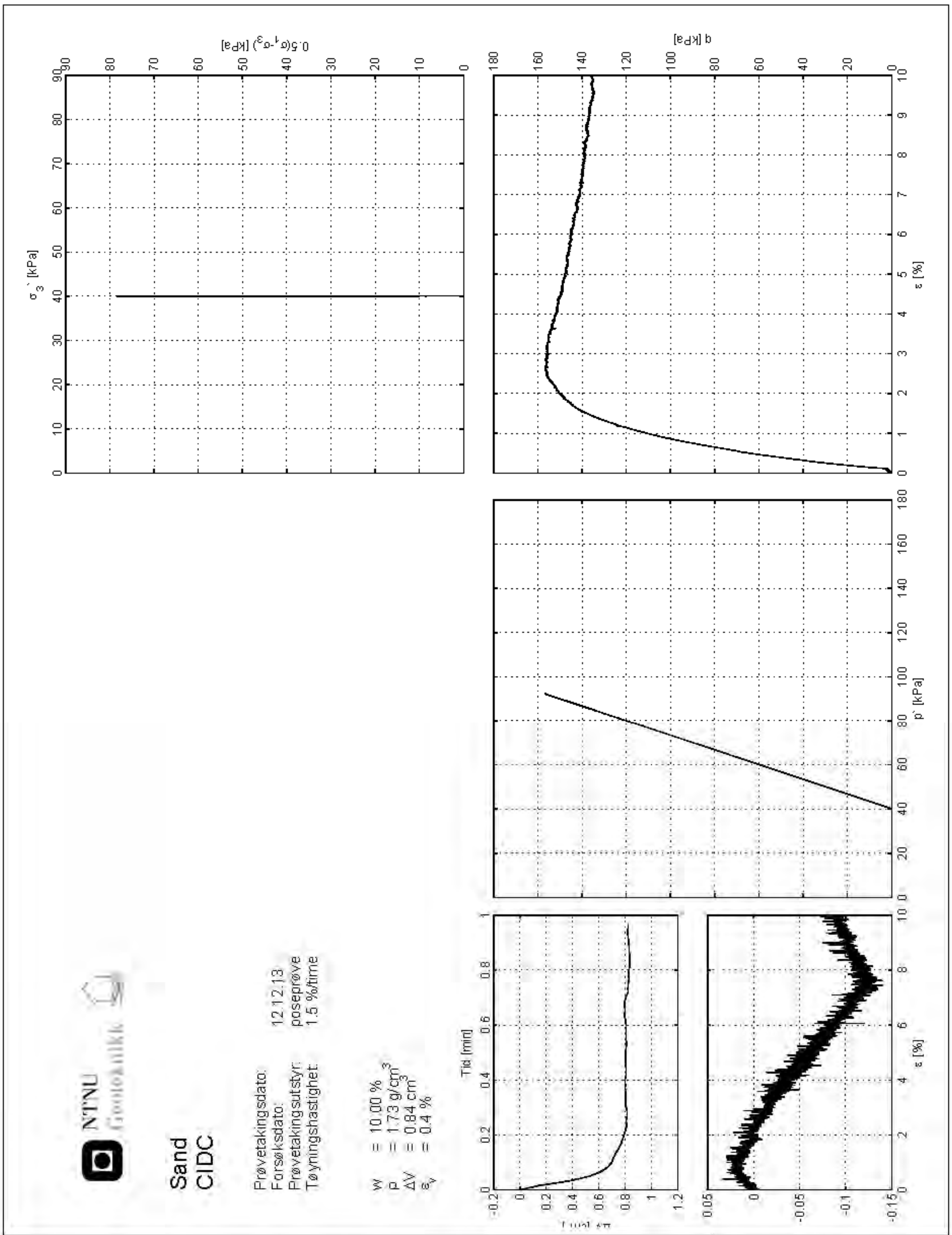
Sand

Kornfordelinger

NTNU Geoteknikk

Hull nr.	Tegnet	Godkjent	Revidert
-	HAK	JJO	
Dybde	**Dato**	**Oppdrags nr.**	**Tegning nr.**
	19.12.2013	2013-30	3

SINTEF



Sand CIUC			NTNU Geoteknikk
Hull nr. -	Tegnet HAK	Godkjent JJO	Revidert
Dybde	Dato 19.12.2013	Oppdrags nr. 2013-30	Tegning nr. 4

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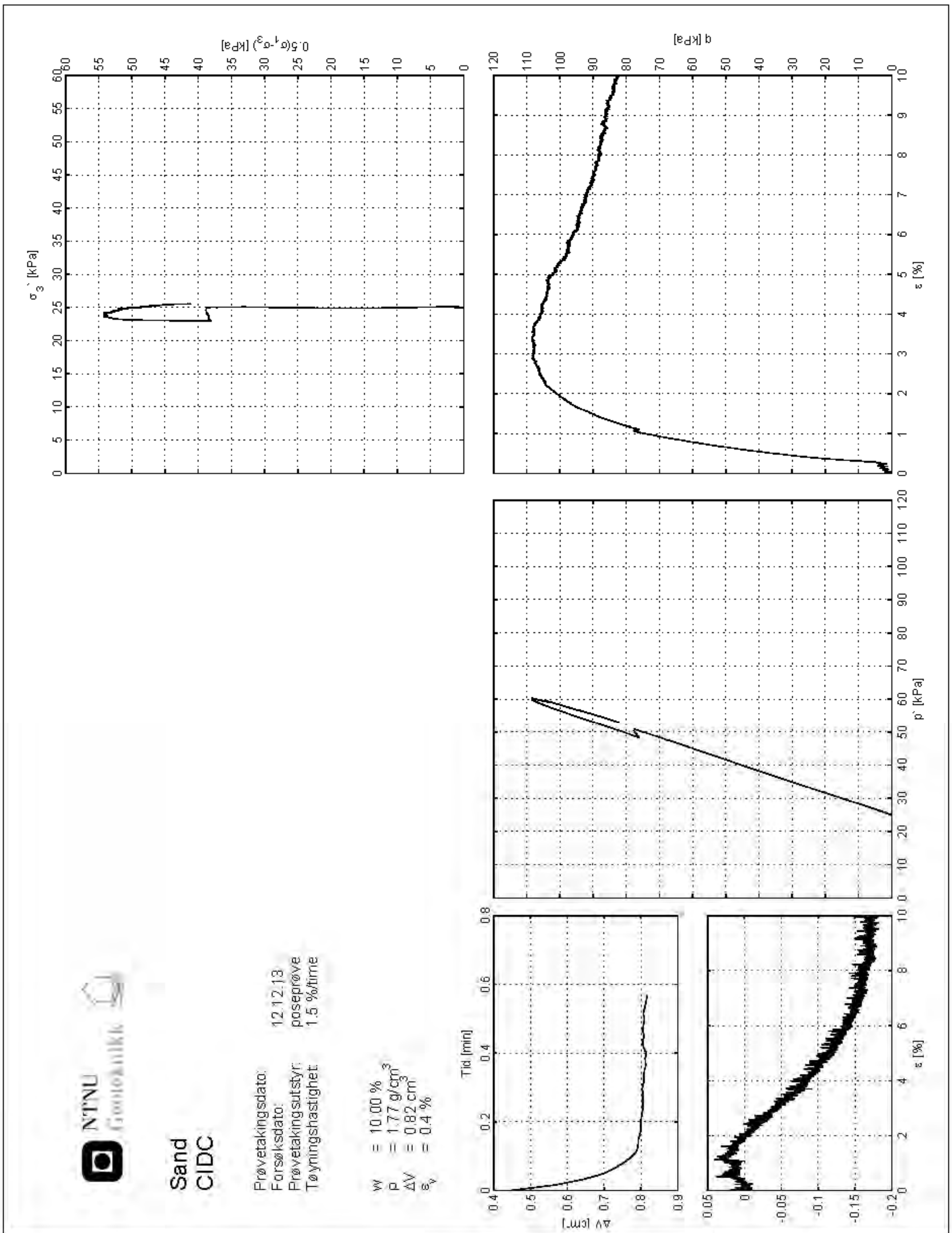


Sand CIUC			NTNU Geoteknikk
Hull nr. -	Tegnet HAK	Godkjent JJO	Revidert
Dybde	Dato 19.12.2013	Oppdrags nr. 2013-30	Tegning nr. 5

Lastetilstander:

Tids-punkt [kl.]	Beskrivelse / Aktivitet	Til-stand nr.	Vann i-/over sand [tonn]	Vann i-/over singel [tonn]	Slag-side [º]	Trim (pos. akterlig) [m]	Minste fribord [m]
1555	Avgang Helle						
2220	Avgang Storasund	8	22,03 (5,4 % vann)	2,14 (0,8 % vann)	0	- 0,44	0,432
2237	Passering Gardsøya						
2306	Passering Tømmerflua	11	46,92 (FMP 11,5 % vann)	24,54 (22,4 nede i porøsitet)	3,5	- 0,59	0,029
2332	Starter snuoperasjon	12	78,31 (mettet 19,2 % vann)	52,79 (50,65 nede i porøsitet)	4,0	- 0,77	- 0,207
2334	Fartøyet får bunnslag						
		24	107,05 (28,74 over sand)	78,66 (mettet 29,4 % vann)	3,2	- 1,01	- 0,299
		25	112,30 (fullt 33,99 over sand)	83,39 (4,73 over grus)	5,4	- 1,08	- 0,490
2339	Mob-båt frigjøres						
		26	112,3 (som 25)	138,32 (fullt 59,66 over grus)	12,1	- 1,44	- 1,184
2340	Fartøyet synker						
	Eks. forskyvning i både sand og singel	17	46,92 (som 11)	24,54 (som 11)	15,9	- 0,64	- 0,954
	Eks. forskyvning kun i singel	18	46,92 (som 11)	24,54 (som 11)	6,4	- 0,59	- 0,189
	Regel ballast 100 % brennolje	2				0,84	
	Som 2 10 % brennolje	3				0,40	
	Regel fullastet d = 3,6 m 100 % brennolje	4	Homogén last ρ = 1,32 t/m^3	Homogén last ρ = 1,32 t/m^3		- 0,79	
	Som 4 10 % brennolje	5				- 1,12	
	Regel fullastet d = 3,725 m 100 % br. olje	6	Homogén last ρ = 1,41 t/m^3	Homogén last ρ = 1,41 t/m^3		- 0,92	
	Som 6 10 % brennolje	7				- 1,24	

Loading Condition no. : 2

Regel ballast 100%

FLOATING CONDITION DATA

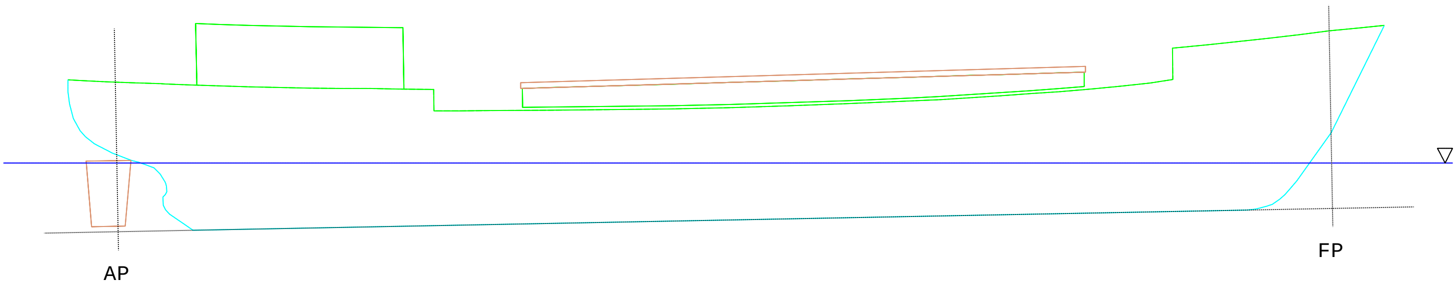
Mean Draught (moulded) :	2.040	m
Trim over Lpp (aft +) :	0.841	m
List (starboard +) ... :	0.000	°
Draught, AP (moulded) :	2.460	m
Draught, LCF (moulded) :	2.044	m
Draught, FP (moulded) :	1.620	m
Displacement .... :	536.502	MT
LCB (rel. AP) .... :	21.201	m
VCB (rel. BL) .... :	1.094	m
LCF (rel. AP) .... :	21.571	m
TPC - Immersion ...... :	3.020	MT/cm
Trim Moment .... :	7.495	MT*m/cm

WEIGHT SUMMARY

100% Forråd :	45.4	MT
Mannskap, Proviant og Stores :	1.1	MT
100% WB :	170.4	MT
Total DEADWEIGHT :	216.9	MT

STABILITY DATA/CONTROL

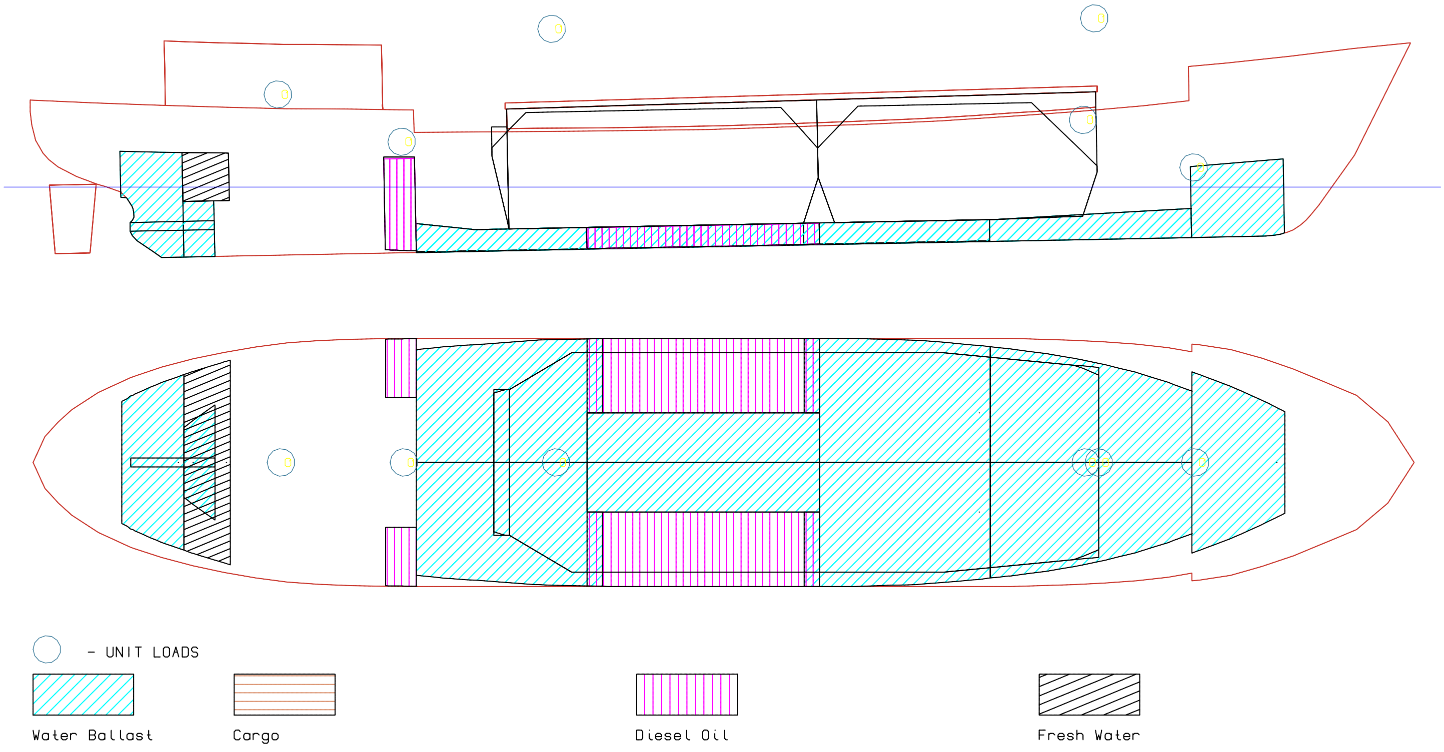
KG (incl. FSC) .... :	2.778	m
Free Surface Correction:	0.036	m
KM (metacentre) ...... :	3.986	m
GM (incl. FSC) .... :	1.208	m
KGmax, intact, calc. . :	3.718	m
Stability Margin ......:	0.940	m
Stability Conclusion . :	OK	



Water Density = 1.025 t/m3

Please note !
-Floating data are based on hydrostatic for upright vessel (zero heel). List is found by use of GM.

Loading Condition no. : 2
Condition Id. text : Regel ballast 100%



WEIGHT LOADS

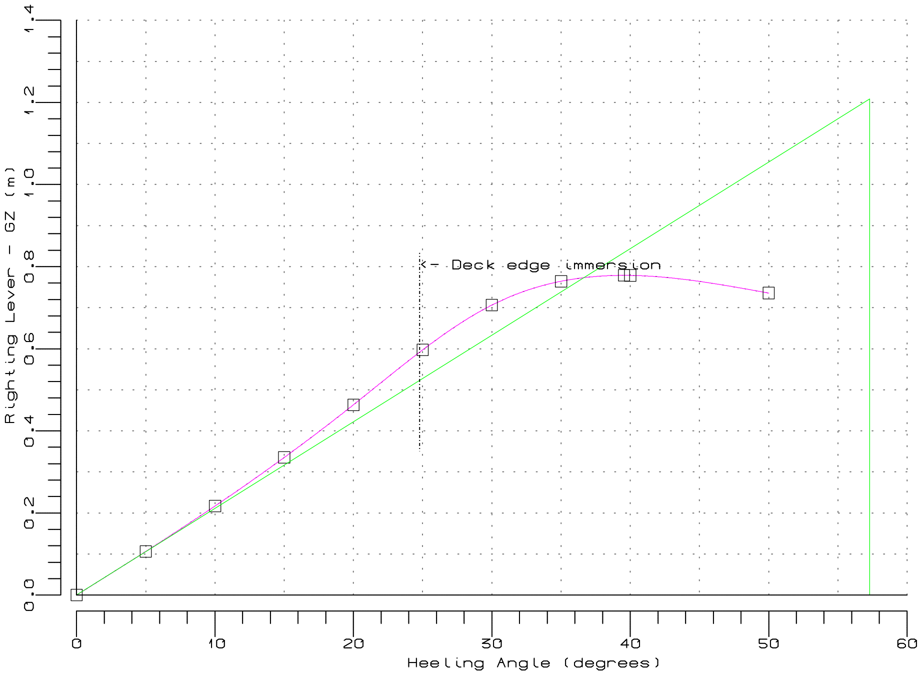
Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
1	100% Forråd									
	- Brennolje DB S	11.109	98.0	0.8300	17.23	25.18	21.216	2.914	0.393	9.09
	- Brennolje DB P	11.109	98.0	0.8300	17.23	25.18	21.216	-2.914	0.393	9.09
	- Brennolje Ving S	4.351	98.0	0.8300	10.34	11.40	10.879	3.100	1.847	0.48
	- Brennolje Ving P	4.351	98.0	0.8300	10.34	11.40	10.879	-3.100	1.847	0.48
	- Dagtank spt. 21-22	0.720					10.970	0.000	3.800	
	- Ferskvann	13.403	100.0	1.0000	3.45	5.04	4.276	0.000	2.777	
	- Smøreolje	0.370					38.020	0.000	2.400	
		45.413					14.210	0.000	1.446	19.14
2	Mannskap, Proviant og Stores									
	- Mannskap, Proviant	0.600					6.770	0.000	5.500	
	- Stores	0.500					34.270	0.000	4.100	
		1.100					19.270	0.000	4.864	
3	100% WB									
	- WB Forpeak	28.386	100.0	1.0250	37.90	41.08	39.296	0.000	1.470	
	- WB 1 S	17.087	100.0	1.0250	31.01	37.90	34.299	1.506	0.470	
	- WB 1 P	17.087	100.0	1.0250	31.01	37.90	34.299	-1.506	0.470	
	- WB 2 S	17.545	100.0	1.0250	24.65	31.01	27.878	2.000	0.399	
	- WB 2 P	17.545	100.0	1.0250	24.65	31.01	27.878	-2.000	0.399	
	- WB 3 S	10.062	100.0	1.0250	17.23	25.18	21.204	0.847	0.379	

.... to be continued on next page

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
-	WB 3 P	10.062	100.0	1.0250	17.23	25.18	21.204	-0.847	0.379	
-	WB 4 S	17.803	100.0	1.0250	11.40	17.76	14.452	1.923	0.423	
-	WB 4 P	17.803	100.0	1.0250	11.40	17.76	14.452	-1.923	0.423	
-	WB Akterpeak	16.984	100.0	1.0250	1.33	4.51	2.863	0.000	2.417	
		170.362					24.980	0.000	0.796	
4	SHT gr.mask. lcg korr.									
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565	
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	
	DEAD WEIGHT	216.875					20.130	0.000	0.952	19.14
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	536.514					21.232	0.000	2.742	19.14

Loading Condition no. : 2
Condition Id. text : Regel ballast 100%

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
0.000	0.000	0.0000
5.000	0.106	0.0046
10.000	0.217	0.0187
15.000	0.335	0.0427
20.000	0.463	0.0775
25.000	0.597	0.1238
30.000	0.706	0.1810
35.000	0.764	0.2455
39.550	0.779	0.3070
40.000	0.779	0.3131
50.000	0.736	0.4461

Deck immersion : 24.785 °
Maximum GZ at : 39.550 °
Equilibrium at : 0.000 °
Area, 0 - 30 : 0.1810 m*rad
Area, 0 - 40 : 0.3131 m*rad
Area,30 - 40 : 0.1321 m*rad
Area, 0 - maxGZ: 0.3070 m*rad
GM : 1.208 m

Heel to starboard side
Applied VCG : 2.778 m
TCG : 0.000 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Concl-usion	KGmax (m)
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.779	OK	3.792
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	39.550	OK	4.201
GMMin	Minimum GM		: 0.15 m	1.208	OK	3.836
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.181	OK	3.718
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.313	OK	3.732
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.132	OK	3.800

ß : flooding angle
ð : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : OK

Resulting KGmax .... (m): 3.718
KG (incl. correction) .... (m): 2.778
Intact stability margin .... (m): 0.940

Please note !

-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)

Flood Opening Results

Loading Condition no. : 2 ,Regel ballast 100%

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Ref. point		14.6	2.5	4.86	**	2.68
2	Lukekarm ved #47	Ref. point		25.2	2.5	4.93	**	2.95
3	Forkant luke	Ref. point		34.7	2.5	5.05	**	3.26

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Freeboard to Deck

Loading Condition no. : 2 ,Regel ballast 100%

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	2.983	2.983
2	-1.300	0.885	5.451	2.965	2.965
3	-0.843	1.388	5.421	2.944	2.944
4	-0.385	1.811	5.391	2.922	2.922
5	0.530	2.392	5.331	2.880	2.880
6	1.625	2.901	5.273	2.843	2.843
7	1.780	2.953	5.265	2.838	2.838
8	2.680	3.256	5.217	2.808	2.808
9	3.755	3.541	5.161	2.773	2.773
10	4.830	3.767	5.105	2.737	2.737
11	5.905	3.955	5.058	2.711	2.711
12	6.980	4.091	5.011	2.685	2.685
13	8.056	4.170	4.983	2.678	2.678
14	9.131	4.215	4.955	2.670	2.670
15	10.206	4.240	4.921	2.657	2.657
16	11.281	4.250	4.888	2.645	2.645
17	11.399	4.250	4.884	2.643	2.643
18	11.400	4.250	4.110	1.869	1.869
19	12.356	4.250	4.098	1.876	1.876
20	13.430	4.250	4.084	1.883	1.883
21	15.580	4.250	4.059	1.899	1.899
22	17.730	4.250	4.037	1.919	1.919
23	19.880	4.250	4.024	1.947	1.947
24	22.030	4.250	4.023	1.988	1.988
25	24.180	4.250	4.053	2.059	2.059
26	26.330	4.250	4.084	2.131	2.131
27	28.480	4.250	4.135	2.224	2.224
28	29.555	4.250	4.166	2.276	2.276
29	30.630	4.250	4.215	2.345	2.345
30	31.705	4.246	4.263	2.415	2.415
31	32.780	4.215	4.317	2.489	2.489
32	33.855	4.182	4.373	2.566	2.566
33	34.930	4.130	4.442	2.656	2.656
34	36.006	4.054	4.518	2.753	2.753
35	37.081	3.933	4.613	2.868	2.868
36	37.900	3.789	4.725	2.996	2.996
37	37.901	4.051	5.851	4.122	4.122
38	38.156	4.031	5.870	4.145	4.145
39	39.230	3.864	5.948	4.244	4.244
40	40.305	3.562	6.041	4.358	4.358
41	41.380	3.195	6.134	4.472	4.472
42	42.455	2.752	6.247	4.605	4.605
43	43.530	2.300	6.359	4.738	4.738
44	44.605	1.386	6.444	4.844	4.844
45	45.500	0.000	6.515	4.932	4.932

Freeboard is vertical distance from deck point to sea at equilibrium.

Loading Condition no. : 3

Som 2, 10%

FLOATING CONDITION DATA

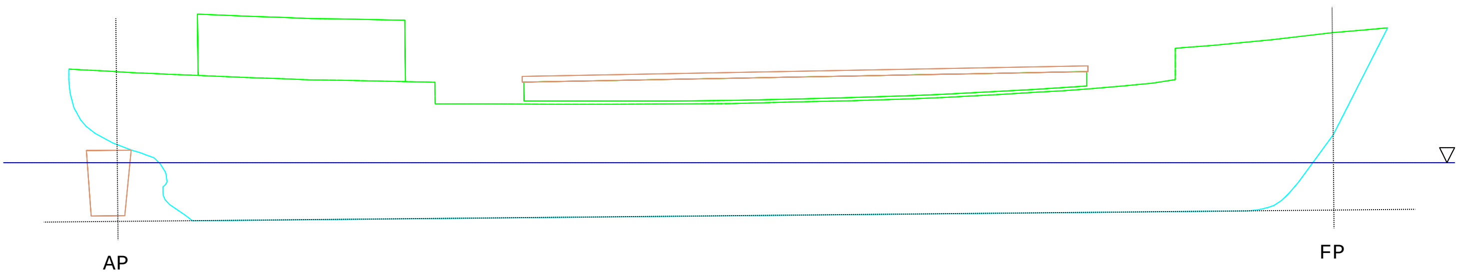
Mean Draught (moulded) :	1.906	m
Trim over Lpp (aft +) :	0.405	m
List (starboard +) ... :	0.000	°
Draught, AP (moulded) :	2.109	m
Draught, LCF (moulded) :	1.905	m
Draught, FP (moulded) :	1.704	m
Displacement .... :	496.621	MT
LCB (rel. AP) .... :	21.791	m
VCB (rel. BL) .... :	1.014	m
LCF (rel. AP) .... :	21.959	m
TPC - Immersion ...... :	2.960	MT/cm
Trim Moment .... :	7.072	MT*m/cm

WEIGHT SUMMARY

10% Forråd :	5.5	MT
Mannskap, Proviant og Stores :	1.1	MT
100% WB :	170.4	MT
Total DEADWEIGHT :	177.0	MT

STABILITY DATA/CONTROL

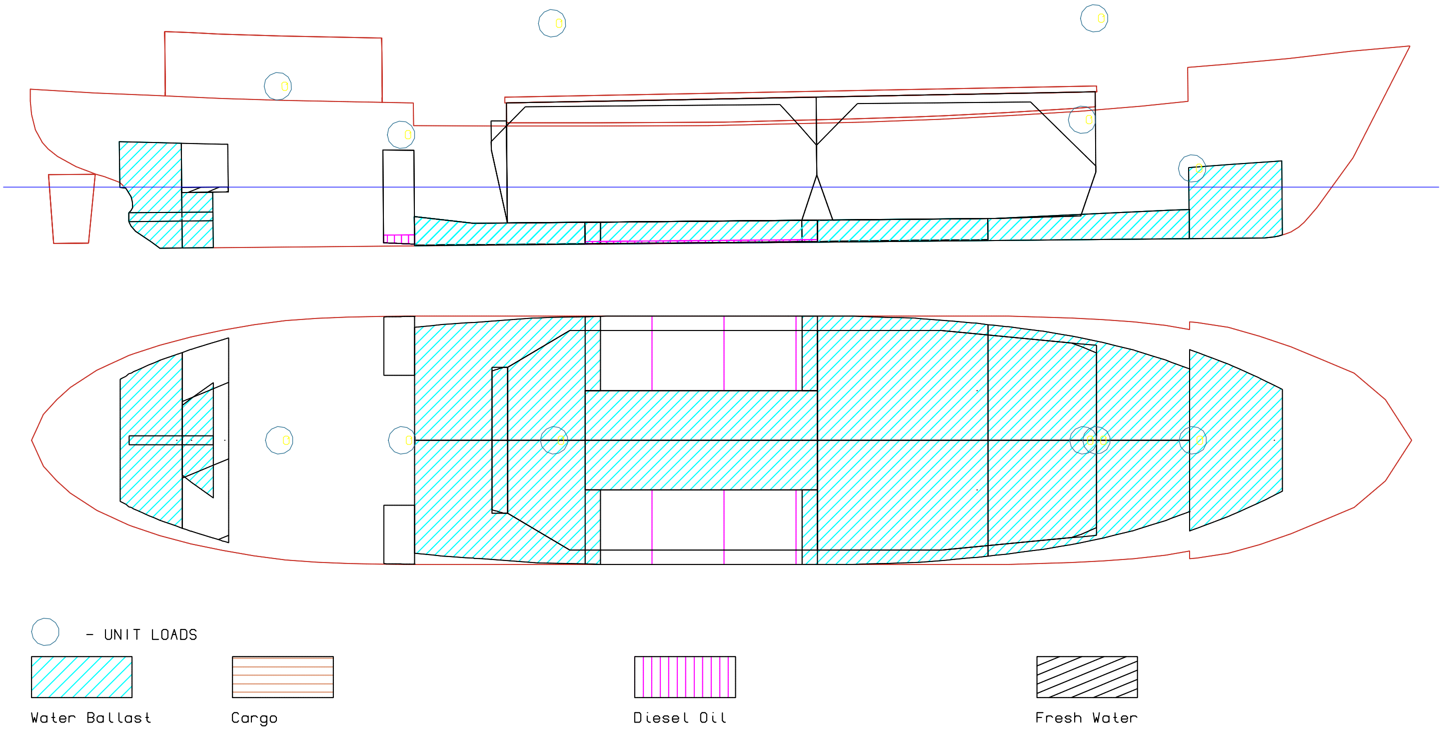
KG (incl. FSC) .... :	2.889	m
Free Surface Correction:	0.045	m
KM (metacentre) ...... :	4.076	m
GM (incl. FSC) .... :	1.187	m
KGmax, intact, calc. . :	3.804	m
Stability Margin ......:	0.914	m
Stability Conclusion . :	OK	



Water Density = 1.025 t/m3

Please note !
-Floating data are based on hydrostatic for upright vessel (zero heel). List is found by use of GM.

Loading Condition no. : 3
Condition Id. text : Som 2, 10%



WEIGHT LOADS

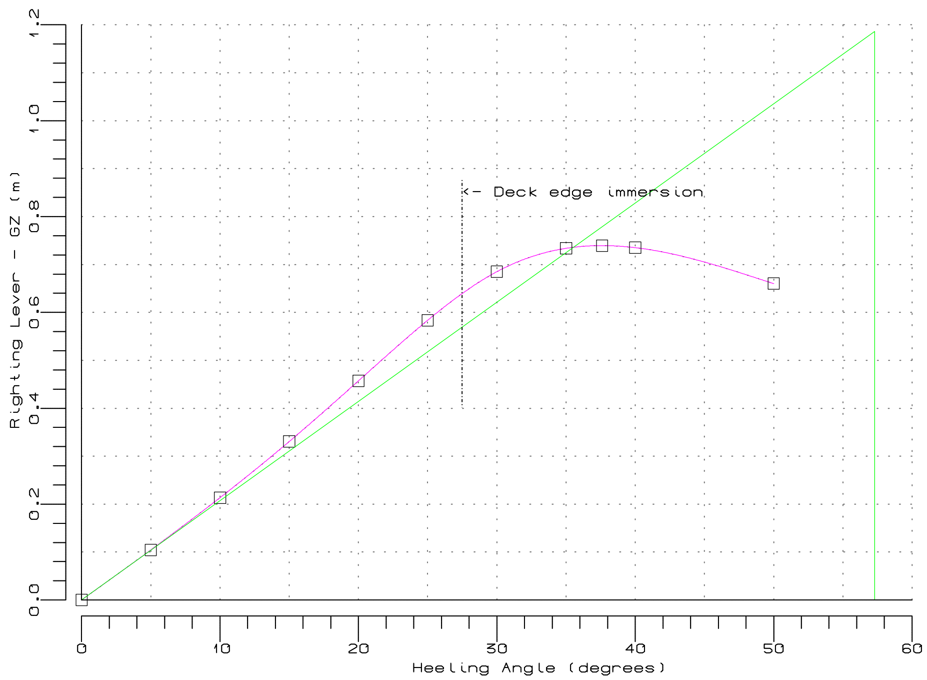
Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
1	10% Forråd									
-	Brennolje DB S	1.111	9.8	0.8300	17.23	25.18	21.222	2.705	0.070	6.05
-	Brennolje DB P	1.111	9.8	0.8300	17.23	25.18	21.222	-2.705	0.070	6.05
-	Brennolje Ving S	0.435	9.8	0.8300	10.34	11.40	10.904	2.723	0.444	0.16
-	Brennolje Ving P	0.435	9.8	0.8300	10.34	11.40	10.904	-2.723	0.444	0.16
-	Dagtank spt. 21-22	0.720					10.970	0.000	3.800	
-	Ferskvann	1.340	10.0	1.0000	3.45	5.04	4.318	0.000	2.014	9.98
-	Smøreolje	0.370					38.020	0.000	2.400	
		5.522					15.282	0.000	1.243	22.40
2	Mannskap, Proviant og Stores									
-	Mannskap, Proviant	0.600					6.770	0.000	5.500	
-	Stores	0.500					34.270	0.000	4.100	
		1.100					19.270	0.000	4.864	
3	100% WB									
-	WB Forpeak	28.386	100.0	1.0250	37.90	41.08	39.296	0.000	1.470	
-	WB 1 S	17.087	100.0	1.0250	31.01	37.90	34.299	1.506	0.470	
-	WB 1 P	17.087	100.0	1.0250	31.01	37.90	34.299	-1.506	0.470	
-	WB 2 S	17.545	100.0	1.0250	24.65	31.01	27.878	2.000	0.399	
-	WB 2 P	17.545	100.0	1.0250	24.65	31.01	27.878	-2.000	0.399	
-	WB 3 S	10.062	100.0	1.0250	17.23	25.18	21.204	0.847	0.379	

.... to be continued on next page

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
-	WB 3 P	10.062	100.0	1.0250	17.23	25.18	21.204	-0.847	0.379	
-	WB 4 S	17.803	100.0	1.0250	11.40	17.76	14.452	1.923	0.423	
-	WB 4 P	17.803	100.0	1.0250	11.40	17.76	14.452	-1.923	0.423	
-	WB Akterpeak	16.984	100.0	1.0250	1.33	4.51	2.863	0.000	2.417	
		170.362					24.980	0.000	0.796	
4	SHT gr.mask. lcg korr.									
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565	
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	
	DEAD WEIGHT	176.984					21.498	0.000	0.835	22.40
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	496.623					21.808	0.000	2.844	22.40

Loading Condition no. : 3
Condition Id. text : Som 2, 10%

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
0.000	0.000	0.0000
5.000	0.105	0.0045
10.000	0.213	0.0184
15.000	0.331	0.0420
20.000	0.457	0.0764
25.000	0.584	0.1218
30.000	0.685	0.1775
35.000	0.734	0.2398
37.600	0.739	0.2733
40.000	0.735	0.3042
50.000	0.660	0.4268

Deck immersion : 27.480 °
Maximum GZ at : 37.600 °
Equilibrium at : 0.000 °
Area, 0 - 30 : 0.1775 m*rad
Area, 0 - 40 : 0.3042 m*rad
Area,30 - 40 : 0.1267 m*rad
Area, 0 - maxGZ: 0.2733 m*rad
GM : 1.187 m

Heel to starboard side
Applied VCG : 2.889 m
TCG : 0.000 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Concl-usion	KGmax (m)
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.739	OK	3.859
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	37.600	OK	4.275
GMMin	Minimum GM		: 0.15 m	1.187	OK	3.926
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.177	OK	3.804
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.304	OK	3.805
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.127	OK	3.856

ß : flooding angle
ð : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : OK

Resulting KGmax .... (m): 3.804
KG (incl. correction) .... (m): 2.889
Intact stability margin .... (m): 0.914

Please note !

-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)

Flood Opening Results

Loading Condition no. : 3 ,Som 2, 10%

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Ref. point		14.6	2.5	4.86	**	2.88
2	Lukekarm ved #47	Ref. point		25.2	2.5	4.93	**	3.05
3	Forkant luke	Ref. point		34.7	2.5	5.05	**	3.26

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Freeboard to Deck

Loading Condition no. : 3 ,Som 2, 10%

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	3.352	3.352
2	-1.300	0.885	5.451	3.330	3.330
3	-0.843	1.388	5.421	3.304	3.304
4	-0.385	1.811	5.391	3.278	3.278
5	0.530	2.392	5.331	3.227	3.227
6	1.625	2.901	5.273	3.179	3.179
7	1.780	2.953	5.265	3.172	3.172
8	2.680	3.256	5.217	3.133	3.133
9	3.755	3.541	5.161	3.087	3.087
10	4.830	3.767	5.105	3.041	3.041
11	5.905	3.955	5.058	3.004	3.004
12	6.980	4.091	5.011	2.967	2.967
13	8.056	4.170	4.983	2.949	2.949
14	9.131	4.215	4.955	2.931	2.931
15	10.206	4.240	4.921	2.907	2.907
16	11.281	4.250	4.888	2.884	2.884
17	11.399	4.250	4.884	2.881	2.881
18	11.400	4.250	4.110	2.107	2.107
19	12.356	4.250	4.098	2.104	2.104
20	13.430	4.250	4.084	2.100	2.100
21	15.580	4.250	4.059	2.095	2.095
22	17.730	4.250	4.037	2.093	2.093
23	19.880	4.250	4.024	2.100	2.100
24	22.030	4.250	4.023	2.119	2.119
25	24.180	4.250	4.053	2.169	2.169
26	26.330	4.250	4.084	2.220	2.220
27	28.480	4.250	4.135	2.291	2.291
28	29.555	4.250	4.166	2.332	2.332
29	30.630	4.250	4.215	2.391	2.391
30	31.705	4.246	4.263	2.449	2.449
31	32.780	4.215	4.317	2.513	2.513
32	33.855	4.182	4.373	2.578	2.578
33	34.930	4.130	4.442	2.658	2.658
34	36.006	4.054	4.518	2.744	2.744
35	37.081	3.933	4.613	2.849	2.849
36	37.900	3.789	4.725	2.969	2.969
37	37.901	4.051	5.851	4.094	4.094
38	38.156	4.031	5.870	4.115	4.115
39	39.230	3.864	5.948	4.204	4.204
40	40.305	3.562	6.041	4.307	4.307
41	41.380	3.195	6.134	4.410	4.410
42	42.455	2.752	6.247	4.532	4.532
43	43.530	2.300	6.359	4.655	4.655
44	44.605	1.386	6.444	4.750	4.750
45	45.500	0.000	6.515	4.829	4.829

Freeboard is vertical distance from deck point to sea at equilibrium.

Loading Condition no. : 4

Regel hom. last 3,6 m, 100%

FLOATING CONDITION DATA

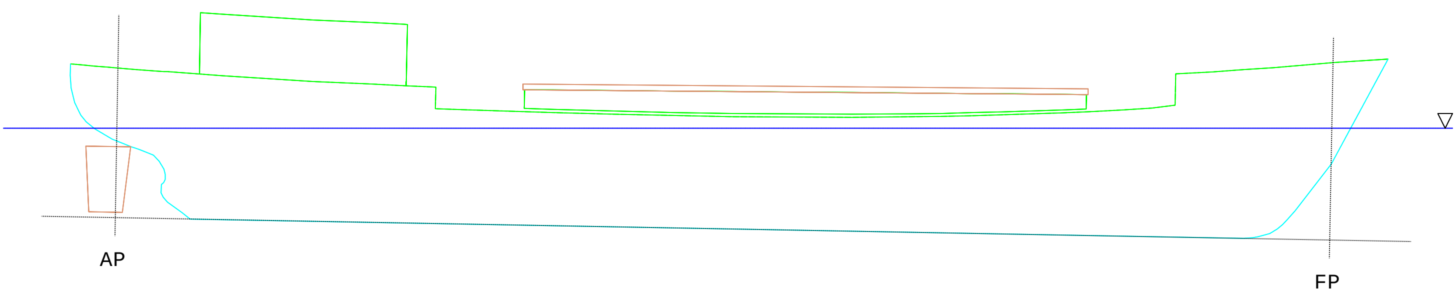
Mean Draught (moulded)	:	3.600 m
Trim over Lpp (aft +)	:	-0.795 m
List (starboard +) ...	:	0.000 °
Draught, AP (moulded)	:	3.202 m
Draught, LCF (moulded)	:	3.599 m
Draught, FP (moulded)	:	3.997 m
Displacement	:	1032.445 MT
LCB (rel. AP)	:	22.799 m
VCB (rel. BL)	:	1.931 m
LCF (rel. AP)	:	21.724 m
TPC - Immersion	:	3.343 MT/cm
Trim Moment	:	9.969 MT*m/cm

WEIGHT SUMMARY

Cargo	:	666.3 MT
100% Forråd	:	45.4 MT
Mannskap, Proviant og Stores	:	1.1 MT
Total DEADWEIGHT	:	712.8 MT

STABILITY DATA/CONTROL

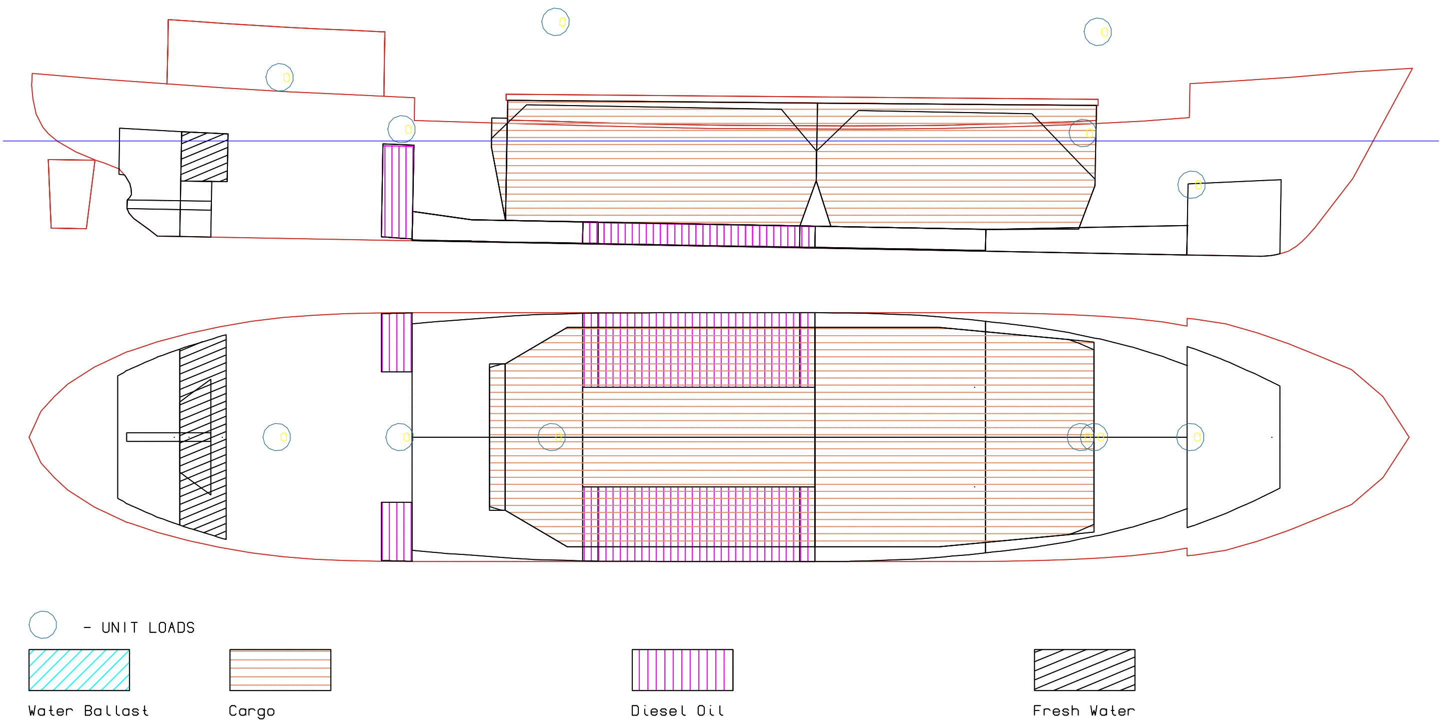
KG (incl. FSC)	:	3.116 m
Free Surface Correction	:	0.019 m
KM (metacentre)	:	3.634 m
GM (incl. FSC)	:	0.518 m
KGmax, intact, calc. .	:	3.017 m
Stability Margin	:	-0.099 m
Stability Conclusion .	:	NOT OK !!



Water Density = 1.025 t/m3

Please note !
-Floating data are based on hydrostatic for upright vessel (zero heel). List is found by use of GM.

Loading Condition no. : 4
Condition Id. text : Regel hom. last 3,6 m, 100%



WEIGHT LOADS

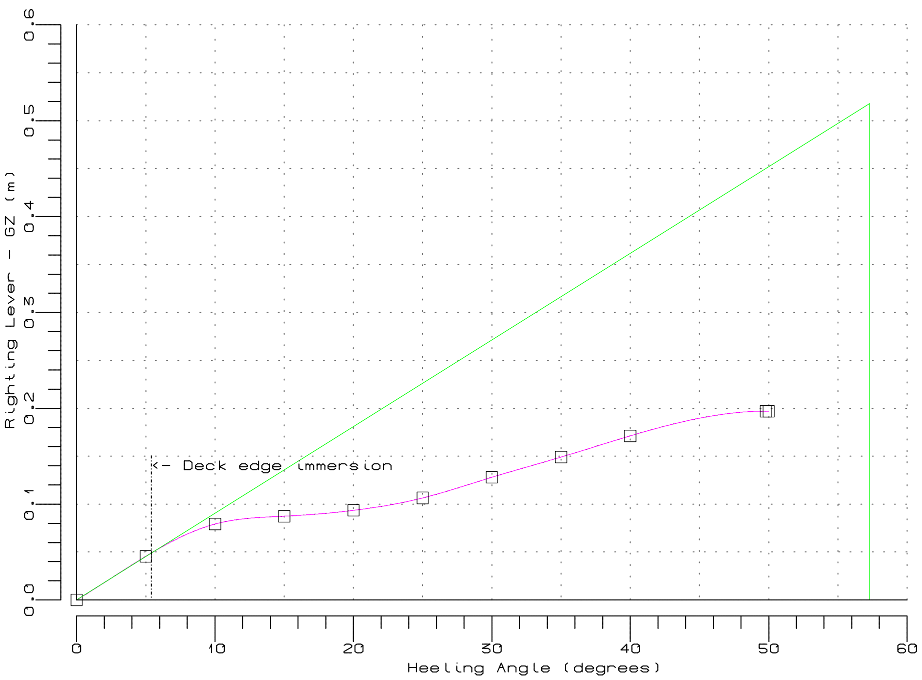
Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
1	100% Forråd									
-	Brennolje DB S	11.109	98.0	0.8300	17.23	25.18	21.216	2.914	0.393	9.09
-	Brennolje DB P	11.109	98.0	0.8300	17.23	25.18	21.216	-2.914	0.393	9.09
-	Brennolje Ving S	4.351	98.0	0.8300	10.34	11.40	10.879	3.100	1.847	0.48
-	Brennolje Ving P	4.351	98.0	0.8300	10.34	11.40	10.879	-3.100	1.847	0.48
-	Dagtank spt. 21-22	0.720					10.970	0.000	3.800	
-	Ferskvann	13.403	100.0	1.0000	3.45	5.04	4.276	0.000	2.777	
-	Smøreolje	0.370					38.020	0.000	2.400	
		45.413					14.210	0.000	1.446	19.14
2	Mannskap, Proviant og Stores									
-	Mannskap, Proviant	0.600					6.770	0.000	5.500	
-	Stores	0.500					34.270	0.000	4.100	
		1.100					19.270	0.000	4.864	
3	Lasterom Forut	313.601	100.0	1.3245	25.18	34.72	29.880	0.000	2.828	
4	Lasterom Akter	352.696	100.0	1.3245	14.05	25.18	19.877	0.000	2.766	
5	SHT gr.mask. lcg korr.									
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565	
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	

.... to be continued on next page

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
	DEAD WEIGHT	712.809					23.135	0.000	2.712	19.14
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	1032.448					22.777	0.000	3.098	19.14

Loading Condition no. : 4
Condition Id. text : Regel hom. last 3,6 m, 100%

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
0.000	0.000	0.0000
5.000	0.046	0.0020
10.000	0.079	0.0076
15.000	0.087	0.0150
20.000	0.093	0.0228
25.000	0.106	0.0315
30.000	0.128	0.0417
35.000	0.149	0.0538
40.000	0.171	0.0678
49.800	0.197	0.0999
50.000	0.197	0.1006

Deck immersion : 5.391 °
Maximum GZ at : 49.800 °
Equilibrium at : 0.000 °
Area, 0 - 30 : 0.0417 m*rad
Area, 0 - 40 : 0.0678 m*rad
Area,30 - 40 : 0.0261 m*rad
Area, 0 - maxGZ: 0.0999 m*rad
GM : 0.518 m

Heel to starboard side
Applied VCG : 3.116 m
TCG : 0.000 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Concl-usion	KGmax (m)
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.197	NOT OK	3.112
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	49.800	OK	3.323
GMMin	Minimum GM		: 0.15 m	0.518	OK	3.484
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.042	NOT OK	3.017
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.068	NOT OK	3.021
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.026	NOT OK	3.077

ß : flooding angle
ð : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : NOT OK

Resulting KGmax .... (m): 3.017
KG (incl. correction) .... (m): 3.116
Intact stability margin .... (m): -0.099

Please note !

-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)

Flood Opening Results

Loading Condition no. : 4 ,Regel hom. last 3,6 m, 100%

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Ref. point		14.6	2.5	4.86	27.11	1.39
2	Lukekarm ved #47	Ref. point		25.2	2.5	4.93	24.30	1.26
3	Forkant luke	Ref. point		34.7	2.5	5.05	22.89	1.21

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Freeboard to Deck

Loading Condition no. : 4 ,Regel hom. last 3,6 m, 100%

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	2.305	2.305
2	-1.300	0.885	5.451	2.272	2.272
3	-0.843	1.388	5.421	2.233	2.233
4	-0.385	1.811	5.391	2.195	2.195
5	0.530	2.392	5.331	2.119	2.119
6	1.625	2.901	5.273	2.040	2.040
7	1.780	2.953	5.265	2.029	2.029
8	2.680	3.256	5.217	1.965	1.965
9	3.755	3.541	5.161	1.890	1.890
10	4.830	3.767	5.105	1.814	1.814
11	5.905	3.955	5.058	1.747	1.747
12	6.980	4.091	5.011	1.681	1.681
13	8.056	4.170	4.983	1.633	1.633
14	9.131	4.215	4.955	1.586	1.586
15	10.206	4.240	4.921	1.532	1.532
16	11.281	4.250	4.888	1.479	1.479
17	11.399	4.250	4.884	1.473	1.473
18	11.400	4.250	4.110	0.699	0.699
19	12.356	4.250	4.098	0.670	0.670
20	13.430	4.250	4.084	0.637	0.637
21	15.580	4.250	4.059	0.572	0.572
22	17.730	4.250	4.037	0.511	0.511
23	19.880	4.250	4.024	0.459	0.459
24	22.030	4.250	4.023	0.418	0.418
25	24.180	4.250	4.053	0.409	0.409
26	26.330	4.250	4.084	0.401	0.401
27	28.480	4.250	4.135	0.413	0.413
28	29.555	4.250	4.166	0.424	0.424
29	30.630	4.250	4.215	0.453	0.453
30	31.705	4.246	4.263	0.482	0.482
31	32.780	4.215	4.317	0.516	0.516
32	33.855	4.182	4.373	0.552	0.552
33	34.930	4.130	4.442	0.602	0.602
34	36.006	4.054	4.518	0.659	0.659
35	37.081	3.933	4.613	0.733	0.733
36	37.900	3.789	4.725	0.831	0.831
37	37.901	4.051	5.851	1.956	1.956
38	38.156	4.031	5.870	1.970	1.970
39	39.230	3.864	5.948	2.029	2.029
40	40.305	3.562	6.041	2.102	2.102
41	41.380	3.195	6.134	2.176	2.176
42	42.455	2.752	6.247	2.269	2.269
43	43.530	2.300	6.359	2.362	2.362
44	44.605	1.386	6.444	2.427	2.427
45	45.500	0.000	6.515	2.482	2.482

Freeboard is vertical distance from deck point to sea at equilibrium.

Loading Condition no. : 5

Som 4, 10%

FLOATING CONDITION DATA

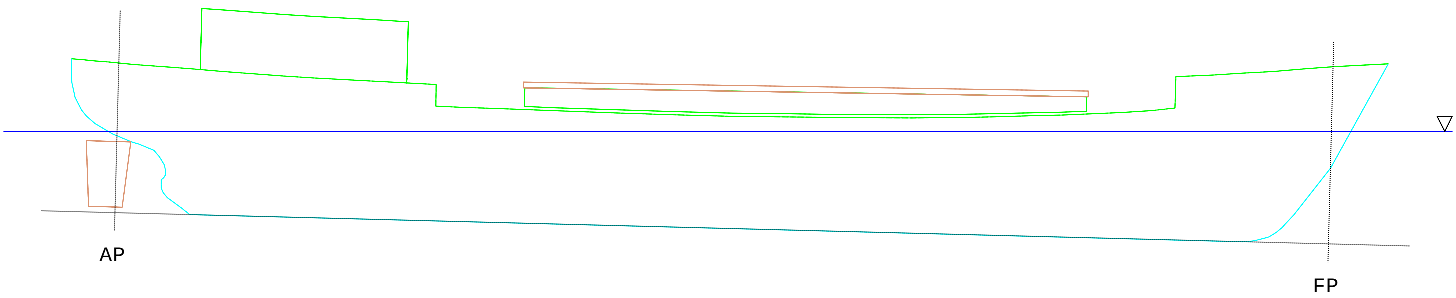
Mean Draught (moulded)	:	3.479 m
Trim over Lpp (aft +)	:	-1.123 m
List (starboard +) ...	:	0.000 °
Draught, AP (moulded)	:	2.918 m
Draught, LCF (moulded)	:	3.484 m
Draught, FP (moulded)	:	4.041 m
Displacement	:	992.553 MT
LCB (rel. AP)	:	23.161 m
VCB (rel. BL)	:	1.873 m
LCF (rel. AP)	:	21.949 m
TPC - Immersion	:	3.308 MT/cm
Trim Moment	:	9.644 MT*m/cm

WEIGHT SUMMARY

Cargo	:	666.3 MT
10% Forråd	:	5.5 MT
Mannskap, Proviant og Stores	:	1.1 MT
Total DEADWEIGHT	:	672.9 MT

STABILITY DATA/CONTROL

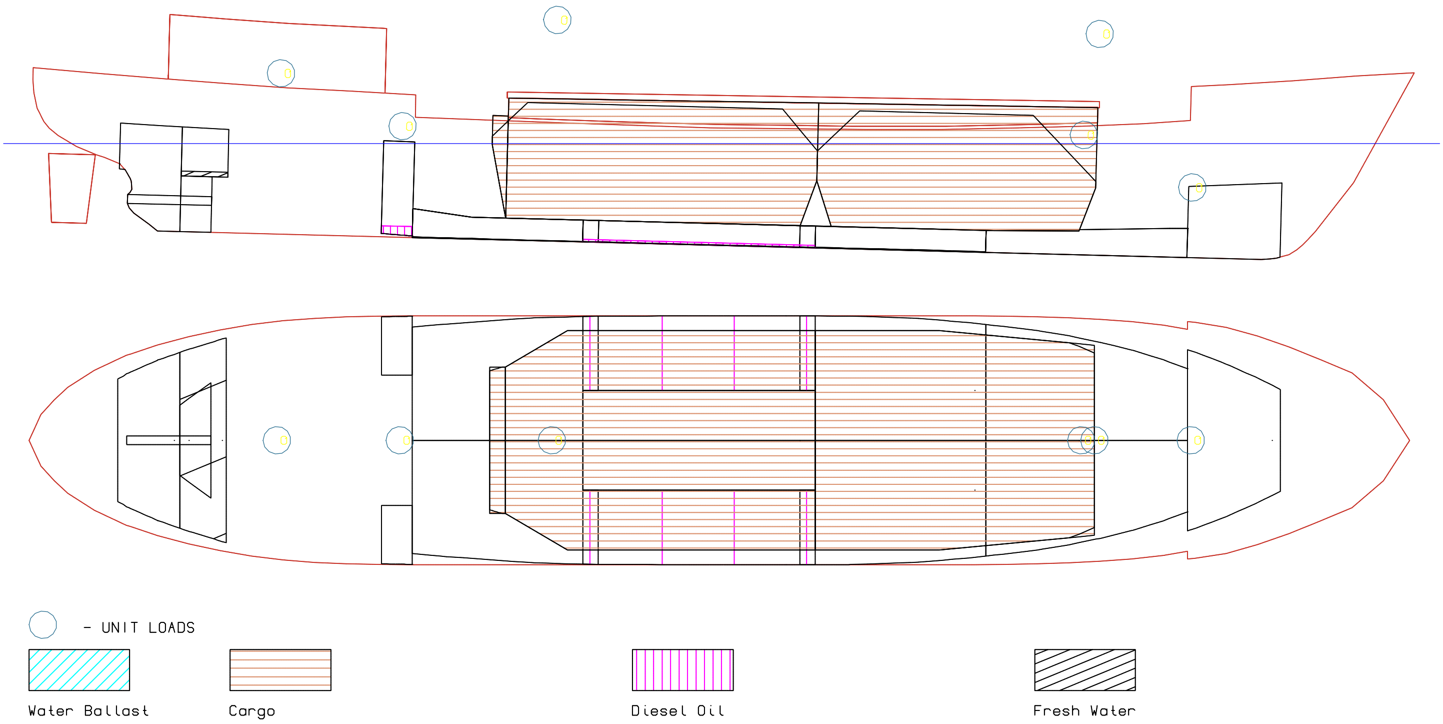
KG (incl. FSC)	:	3.186 m
Free Surface Correction	:	0.023 m
KM (metacentre)	:	3.626 m
GM (incl. FSC)	:	0.440 m
KGmax, intact, calc. . .	:	3.047 m
Stability Margin	:	-0.139 m
Stability Conclusion . .	:	NOT OK !!



Water Density = 1.025 t/m3

Please note !
-Floating data are based on hydrostatic for upright vessel (zero heel). List is found by use of GM.

Loading Condition no. : 5
Condition Id. text : Som 4, 10%



WEIGHT LOADS

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
1	10% Forråd									
-	Brennolje DB S	1.111	9.8	0.8300	17.23	25.18	21.222	2.705	0.070	6.05
-	Brennolje DB P	1.111	9.8	0.8300	17.23	25.18	21.222	-2.705	0.070	6.05
-	Brennolje Ving S	0.435	9.8	0.8300	10.34	11.40	10.904	2.723	0.444	0.16
-	Brennolje Ving P	0.435	9.8	0.8300	10.34	11.40	10.904	-2.723	0.444	0.16
-	Dagtank spt. 21-22	0.720					10.970	0.000	3.800	
-	Ferskvann	1.340	10.0	1.0000	3.45	5.04	4.318	0.000	2.014	9.98
-	Smøreolje	0.370					38.020	0.000	2.400	
		5.522					15.282	0.000	1.243	22.40
2	Mannskap, Proviant og Stores									
-	Mannskap, Proviant	0.600					6.770	0.000	5.500	
-	Stores	0.500					34.270	0.000	4.100	
		1.100					19.270	0.000	4.864	
3	Lasterom Forut	313.601	100.0	1.3245	25.18	34.72	29.880	0.000	2.828	
4	Lasterom Akter	352.696	100.0	1.3245	14.05	25.18	19.877	0.000	2.766	
5	SHT gr.mask. lcg korr.									
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565	
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	

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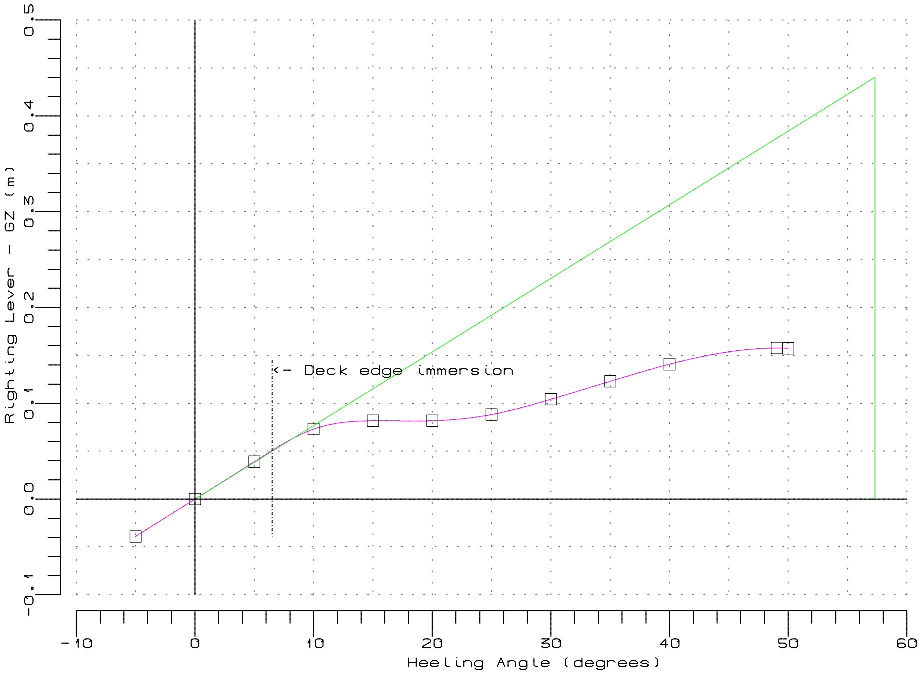
Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
	DEAD WEIGHT	672.918					23.673	0.000	2.786	22.40
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	992.557					23.127	0.000	3.163	22.40

Loading Condition no. : 5
Condition Id. text : Som 4, 10%

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
-5.000	-0.039	-0.0017
0.000	0.000	0.0000
5.000	0.039	0.0017
10.000	0.073	0.0067
15.000	0.082	0.0136
20.000	0.082	0.0207
25.000	0.088	0.0281
30.000	0.104	0.0365
35.000	0.123	0.0464
40.000	0.141	0.0579
49.050	0.158	0.0818
50.000	0.157	0.0844

Deck immersion : 6.504 °
Maximum GZ at : 49.050 °
Equilibrium at : 0.000 °
Area, 0 - 30 : 0.0365 m*rad
Area, 0 - 40 : 0.0579 m*rad
Area,30 - 40 : 0.0214 m*rad
Area, 0 - maxGZ: 0.0818 m*rad
GM : 0.440 m

Heel to starboard side
Applied VCG : 3.186 m
TCG : 0.000 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Concl-usion	KGmax (m)
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.158	NOT OK	3.130
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	49.050	OK	3.335
GMMin	Minimum GM		: 0.15 m	0.440	OK	3.476
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.036	NOT OK	3.047
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.058	NOT OK	3.048
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.021	NOT OK	3.100

ß : flooding angle
ð : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : NOT OK

Resulting KGmax .... (m): 3.047
KG (incl. correction) .... (m): 3.186
Intact stability margin .... (m): -0.139

Please note !

-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)

Flood Opening Results

Loading Condition no. : 5 ,Som 4, 10%

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Ref. point		14.6	2.5	4.86	30.35	1.56
2	Lukekarm ved #47	Ref. point		25.2	2.5	4.93	26.13	1.36
3	Forkant luke	Ref. point		34.7	2.5	5.05	23.48	1.24

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Freeboard to Deck

Loading Condition no. : 5 ,Som 4, 10%

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	2.602	2.602
2	-1.300	0.885	5.451	2.566	2.566
3	-0.843	1.388	5.421	2.524	2.524
4	-0.385	1.811	5.391	2.482	2.482
5	0.530	2.392	5.331	2.399	2.399
6	1.625	2.901	5.273	2.312	2.312
7	1.780	2.953	5.265	2.300	2.300
8	2.680	3.256	5.217	2.229	2.229
9	3.755	3.541	5.161	2.146	2.146
10	4.830	3.767	5.105	2.062	2.062
11	5.905	3.955	5.058	1.987	1.987
12	6.980	4.091	5.011	1.913	1.913
13	8.056	4.170	4.983	1.857	1.857
14	9.131	4.215	4.955	1.801	1.801
15	10.206	4.240	4.921	1.740	1.740
16	11.281	4.250	4.888	1.678	1.678
17	11.399	4.250	4.884	1.672	1.672
18	11.400	4.250	4.110	0.898	0.898
19	12.356	4.250	4.098	0.861	0.861
20	13.430	4.250	4.084	0.820	0.820
21	15.580	4.250	4.059	0.739	0.739
22	17.730	4.250	4.037	0.662	0.662
23	19.880	4.250	4.024	0.594	0.594
24	22.030	4.250	4.023	0.537	0.537
25	24.180	4.250	4.053	0.512	0.512
26	26.330	4.250	4.084	0.487	0.487
27	28.480	4.250	4.135	0.483	0.483
28	29.555	4.250	4.166	0.486	0.486
29	30.630	4.250	4.215	0.507	0.507
30	31.705	4.246	4.263	0.528	0.528
31	32.780	4.215	4.317	0.553	0.553
32	33.855	4.182	4.373	0.581	0.581
33	34.930	4.130	4.442	0.623	0.623
34	36.006	4.054	4.518	0.672	0.672
35	37.081	3.933	4.613	0.738	0.738
36	37.900	3.789	4.725	0.830	0.830
37	37.901	4.051	5.851	1.955	1.955
38	38.156	4.031	5.870	1.967	1.967
39	39.230	3.864	5.948	2.018	2.018
40	40.305	3.562	6.041	2.083	2.083
41	41.380	3.195	6.134	2.148	2.148
42	42.455	2.752	6.247	2.233	2.233
43	43.530	2.300	6.359	2.318	2.318
44	44.605	1.386	6.444	2.375	2.375
45	45.500	0.000	6.515	2.423	2.423

Freeboard is vertical distance from deck point to sea at equilibrium.

Loading Condition no. : 6

Regel hom. last 3,725 m, 100%

FLOATING CONDITION DATA

Mean Draught (moulded)	:	3.725 m
Trim over Lpp (aft +)	:	-0.916 m
List (starboard +) ...	:	0.000 °
Draught, AP (moulded)	:	3.267 m
Draught, LCF (moulded)	:	3.725 m
Draught, FP (moulded)	:	4.184 m

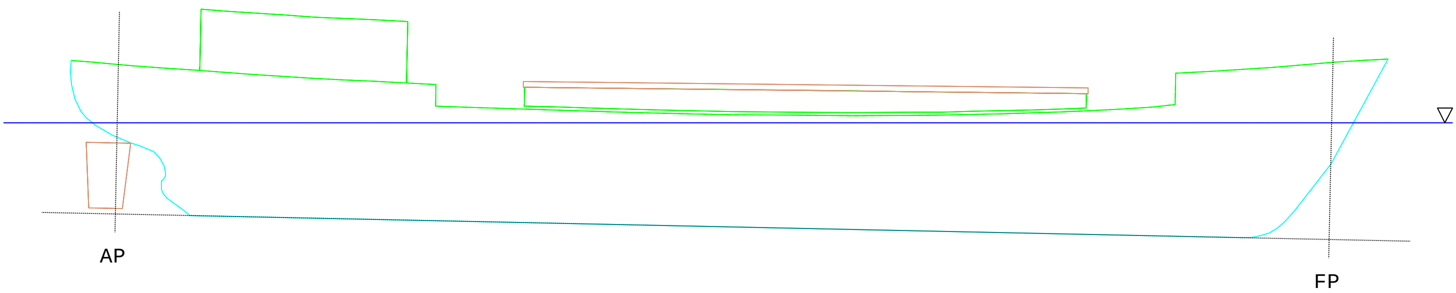
Displacement	:	1074.577 MT
LCB (rel. AP)	:	22.871 m
VCB (rel. BL)	:	2.001 m
LCF (rel. AP)	:	21.749 m
TPC - Immersion	:	3.365 MT/cm
Trim Moment	:	10.161 MT*m/cm

WEIGHT SUMMARY

Cargo	:	708.4 MT
100% Forråd	:	45.4 MT
Mannskap, Proviant og Stores	:	1.1 MT
Total DEADWEIGHT	:	754.9 MT

STABILITY DATA/CONTROL

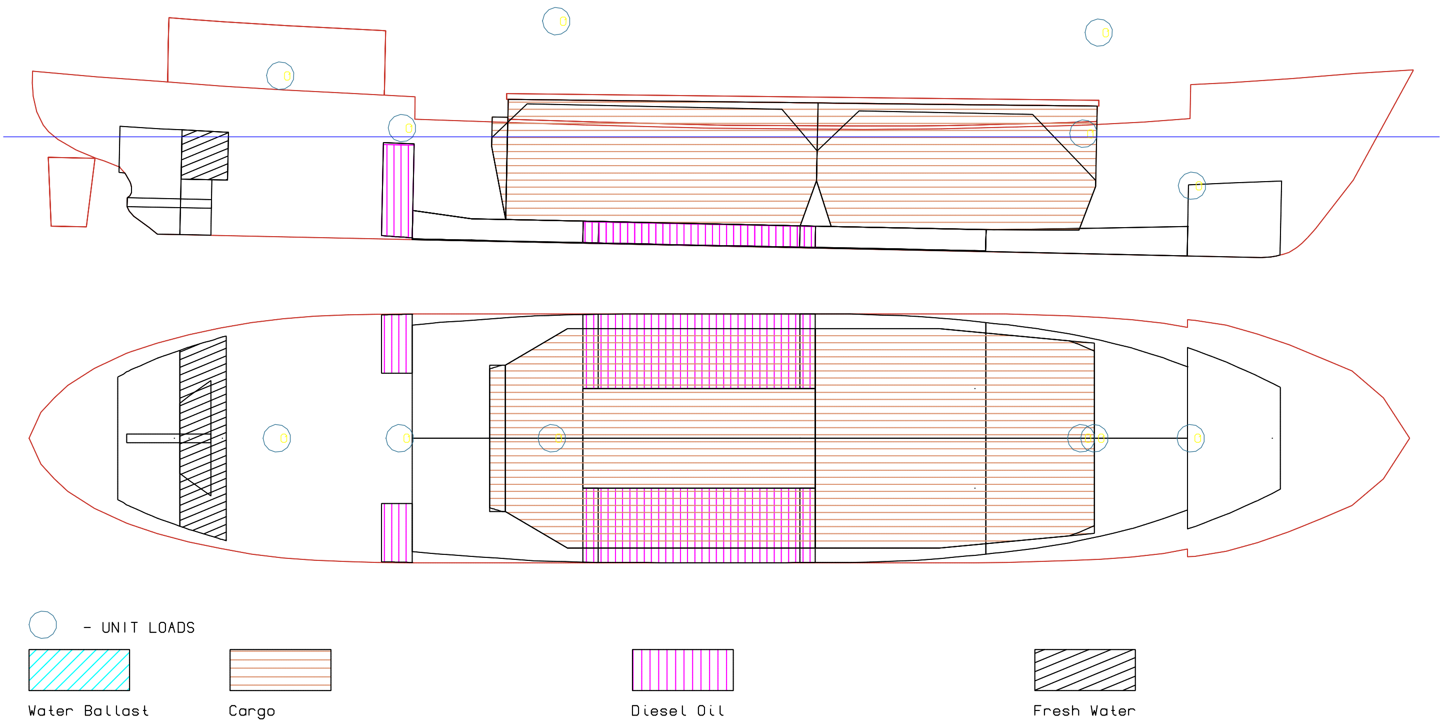
KG (incl. FSC)	:	3.104 m
Free Surface Correction	:	0.018 m
KM (metacentre)	:	3.650 m
GM (incl. FSC)	:	0.547 m
KGmax, intact, calc. .	:	2.976 m
Stability Margin	:	-0.128 m
Stability Conclusion .	:	NOT OK !!



Water Density = 1.025 t/m3

Please note !
-Floating data are based on hydrostatic for upright vessel (zero heel). List is found by use of GM.

Loading Condition no. : 6
Condition Id. text : Regel hom. last 3,725 m, 100%



WEIGHT LOADS

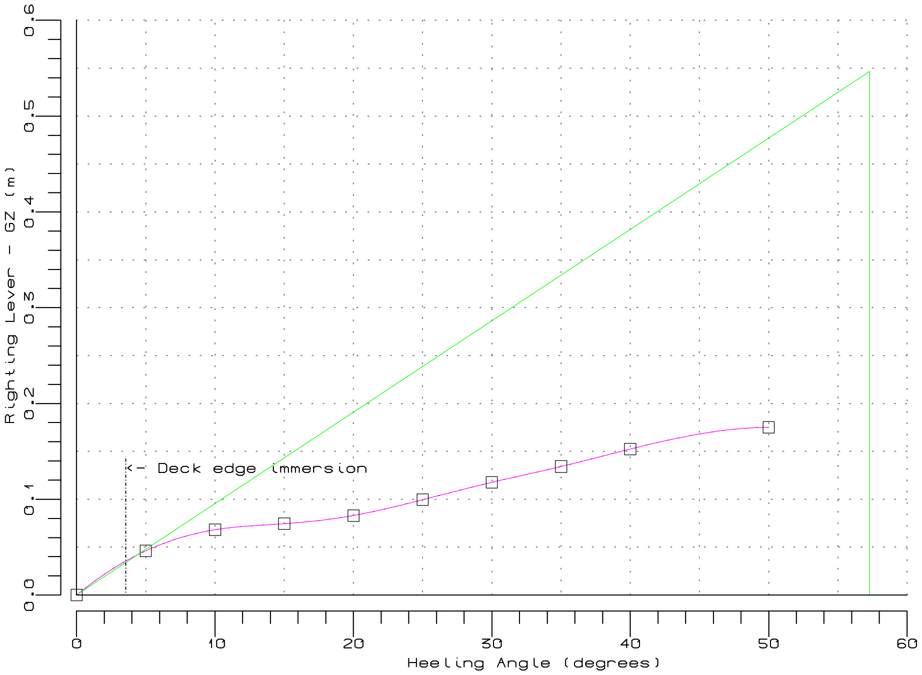
Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
1	100% Forråd									
-	Brennolje DB S	11.109	98.0	0.8300	17.23	25.18	21.216	2.914	0.393	9.09
-	Brennolje DB P	11.109	98.0	0.8300	17.23	25.18	21.216	-2.914	0.393	9.09
-	Brennolje Ving S	4.351	98.0	0.8300	10.34	11.40	10.879	3.100	1.847	0.48
-	Brennolje Ving P	4.351	98.0	0.8300	10.34	11.40	10.879	-3.100	1.847	0.48
-	Dagtank spt. 21-22	0.720					10.970	0.000	3.800	
-	Ferskvann	13.403	100.0	1.0000	3.45	5.04	4.276	0.000	2.777	
-	Smøreolje	0.370					38.020	0.000	2.400	
		45.413					14.210	0.000	1.446	19.14
2	Mannskap, Proviant og Stores									
-	Mannskap, Proviant	0.600					6.770	0.000	5.500	
-	Stores	0.500					34.270	0.000	4.100	
		1.100					19.270	0.000	4.864	
3	Lasterom Forut	333.430	100.0	1.4083	25.18	34.72	29.880	0.000	2.828	
4	Lasterom Akter	374.997	100.0	1.4083	14.05	25.18	19.877	0.000	2.766	
5	SHT gr.mask. lcg korr.									
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565	
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	

.... to be continued on next page

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
	DEAD WEIGHT	754.939					23.216	0.000	2.717	19.14
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	1074.578					22.848	0.000	3.086	19.14

Loading Condition no. : 6
Condition Id. text : Regel hom. last 3,725 m, 100%

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
0.000	0.000	0.0000
5.000	0.046	0.0022
10.000	0.068	0.0074
15.000	0.074	0.0136
20.000	0.083	0.0204
25.000	0.100	0.0284
30.000	0.118	0.0379
35.000	0.134	0.0488
40.000	0.152	0.0613
50.000	0.175	0.0904

Deck immersion : 3.555 °
Maximum GZ at : 50.000 °
Equilibrium at : 0.000 °
Area, 0 - 30 : 0.0379 m*rad
Area, 0 - 40 : 0.0613 m*rad
Area,30 - 40 : 0.0235 m*rad
Area, 0 - maxGZ: 0.0904 m*rad
GM : 0.547 m

Heel to starboard side
Applied VCG : 3.104 m
TCG : 0.000 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Conclusion	KGmax (m)
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.175	NOT OK	3.071
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	50.000	OK	3.291
GMMin	Minimum GM		: 0.15 m	0.547	OK	3.500
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.038	NOT OK	2.976
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.061	NOT OK	2.981
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.023	NOT OK	3.039

ß : flooding angle
ð : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : NOT OK

Resulting KGmax .... (m): 2.976
KG (incl. correction) .... (m): 3.104
Intact stability margin .... (m): -0.128

Please note !

-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)

Flood Opening Results

Loading Condition no. : 6 ,Regel hom. last 3,725 m, 100%

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Ref. point		14.6	2.5	4.86	25.00	1.28
2	Lukekarm ved #47	Ref. point		25.2	2.5	4.93	21.64	1.13
3	Forkant luke	Ref. point		34.7	2.5	5.05	19.80	1.05

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Freeboard to Deck

Loading Condition no. : 6 ,Regel hom. last 3,725 m, 100%

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	2.245	2.245
2	-1.300	0.885	5.451	2.210	2.210
3	-0.843	1.388	5.421	2.171	2.171
4	-0.385	1.811	5.391	2.131	2.131
5	0.530	2.392	5.331	2.052	2.052
6	1.625	2.901	5.273	1.971	1.971
7	1.780	2.953	5.265	1.960	1.960
8	2.680	3.256	5.217	1.893	1.893
9	3.755	3.541	5.161	1.814	1.814
10	4.830	3.767	5.105	1.736	1.736
11	5.905	3.955	5.058	1.666	1.666
12	6.980	4.091	5.011	1.596	1.596
13	8.056	4.170	4.983	1.546	1.546
14	9.131	4.215	4.955	1.495	1.495
15	10.206	4.240	4.921	1.439	1.439
16	11.281	4.250	4.888	1.383	1.383
17	11.399	4.250	4.884	1.376	1.376
18	11.400	4.250	4.110	0.603	0.603
19	12.356	4.250	4.098	0.570	0.570
20	13.430	4.250	4.084	0.534	0.534
21	15.580	4.250	4.059	0.463	0.463
22	17.730	4.250	4.037	0.396	0.396
23	19.880	4.250	4.024	0.339	0.339
24	22.030	4.250	4.023	0.292	0.292
25	24.180	4.250	4.053	0.277	0.277
26	26.330	4.250	4.084	0.262	0.262
27	28.480	4.250	4.135	0.268	0.268
28	29.555	4.250	4.166	0.277	0.277
29	30.630	4.250	4.215	0.303	0.303
30	31.705	4.246	4.263	0.329	0.329
31	32.780	4.215	4.317	0.359	0.359
32	33.855	4.182	4.373	0.393	0.393
33	34.930	4.130	4.442	0.440	0.440
34	36.006	4.054	4.518	0.493	0.493
35	37.081	3.933	4.613	0.565	0.565
36	37.900	3.789	4.725	0.660	0.660
37	37.901	4.051	5.851	1.785	1.785
38	38.156	4.031	5.870	1.799	1.799
39	39.230	3.864	5.948	1.854	1.854
40	40.305	3.562	6.041	1.925	1.925
41	41.380	3.195	6.134	1.995	1.995
42	42.455	2.752	6.247	2.085	2.085
43	43.530	2.300	6.359	2.175	2.175
44	44.605	1.386	6.444	2.237	2.237
45	45.500	0.000	6.515	2.289	2.289

Freeboard is vertical distance from deck point to sea at equilibrium.

Loading Condition no. : 7

Som 6, 10%

FLOATING CONDITION DATA

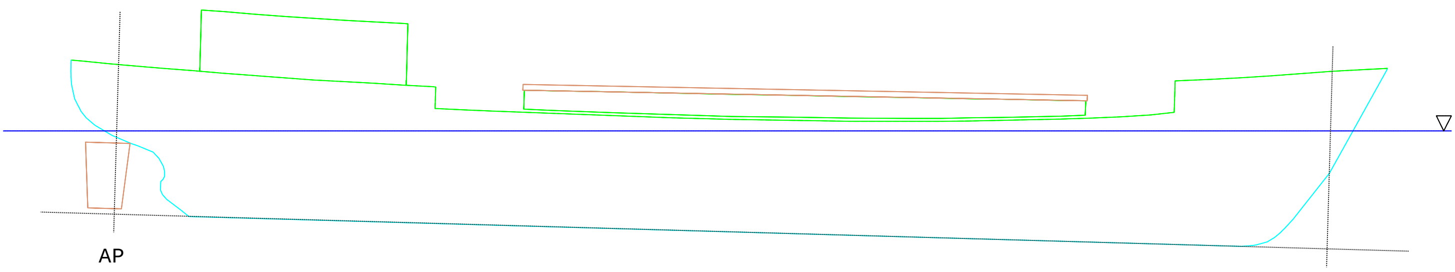
Mean Draught (moulded)	:	3.606 m
Trim over Lpp (aft +)	:	-1.239 m
List (starboard +) ...	:	0.000 °
Draught, AP (moulded)	:	2.986 m
Draught, LCF (moulded)	:	3.611 m
Draught, FP (moulded)	:	4.225 m
Displacement	:	1034.684 MT
LCB (rel. AP)	:	23.221 m
VCB (rel. BL)	:	1.944 m
LCF (rel. AP)	:	21.972 m
TPC - Immersion	:	3.331 MT/cm
Trim Moment	:	9.832 MT*m/cm

WEIGHT SUMMARY

Cargo	:	708.4 MT
10% Forråd	:	5.5 MT
Mannskap, Proviant og Stores	:	1.1 MT
Total DEADWEIGHT	:	715.0 MT

STABILITY DATA/CONTROL

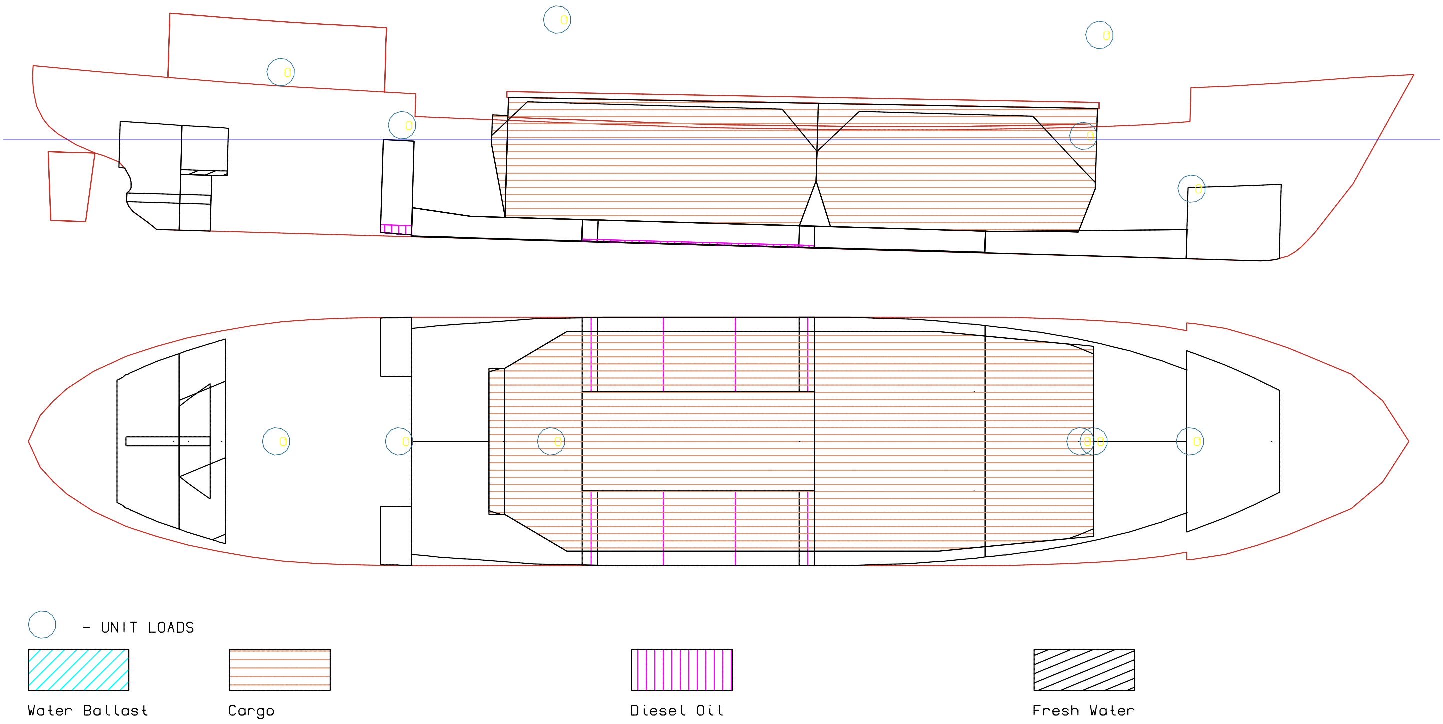
KG (incl. FSC)	:	3.170 m
Free Surface Correction	:	0.022 m
KM (metacentre)	:	3.639 m
GM (incl. FSC)	:	0.470 m
KGmax, intact, calc. .	:	3.005 m
Stability Margin	:	-0.164 m
Stability Conclusion .	:	NOT OK !!



Water Density = 1.025 t/m3

Please note !
-Floating data are based on hydrostatic for upright vessel (zero heel). List is found by use of GM.

Loading Condition no. : 7
Condition Id. text : Som 6, 10%



WEIGHT LOADS

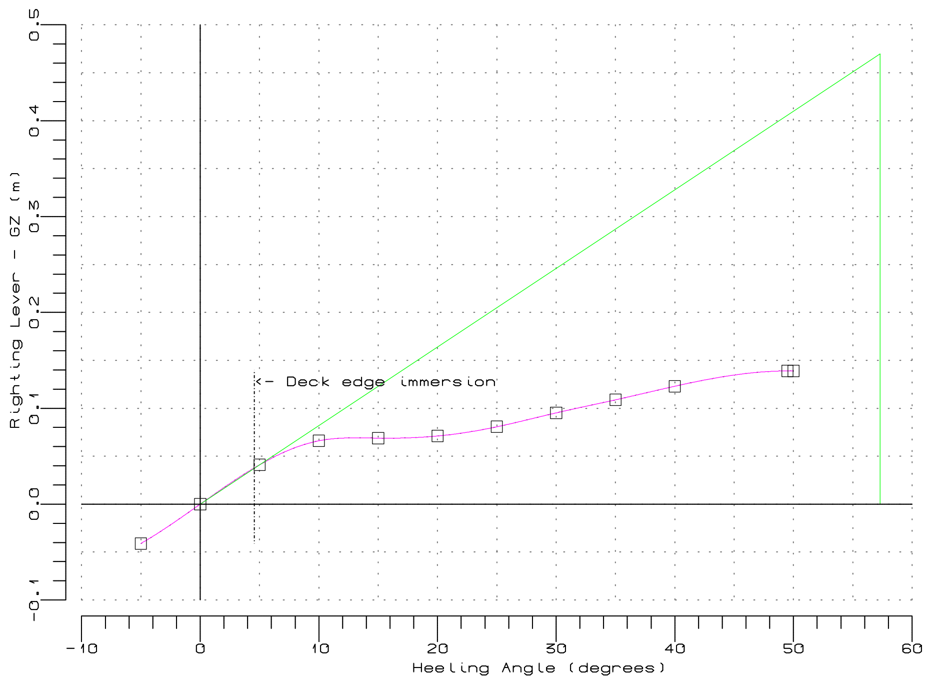
Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
1	10% Forråd									
-	Brennolje DB S	1.111	9.8	0.8300	17.23	25.18	21.222	2.705	0.070	6.05
-	Brennolje DB P	1.111	9.8	0.8300	17.23	25.18	21.222	-2.705	0.070	6.05
-	Brennolje Ving S	0.435	9.8	0.8300	10.34	11.40	10.904	2.723	0.444	0.16
-	Brennolje Ving P	0.435	9.8	0.8300	10.34	11.40	10.904	-2.723	0.444	0.16
-	Dagtank spt. 21-22	0.720					10.970	0.000	3.800	
-	Ferskvann	1.340	10.0	1.0000	3.45	5.04	4.318	0.000	2.014	9.98
-	Smøreolje	0.370					38.020	0.000	2.400	
		5.522					15.282	0.000	1.243	22.40
2	Mannskap, Proviant og Stores									
-	Mannskap, Proviant	0.600					6.770	0.000	5.500	
-	Stores	0.500					34.270	0.000	4.100	
		1.100					19.270	0.000	4.864	
3	Lasterom Forut	333.430	100.0	1.4083	25.18	34.72	29.880	0.000	2.828	
4	Lasterom Akter	374.997	100.0	1.4083	14.05	25.18	19.877	0.000	2.766	
5	SHT gr.mask. lcg korr.									
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565	
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	

.... to be continued on next page

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
	DEAD WEIGHT	715.049					23.727	0.000	2.786	22.40
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	1034.688					23.187	0.000	3.148	22.40

Loading Condition no. : 7
Condition Id. text : Som 6, 10%

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
-5.000	-0.041	-0.0019
0.000	0.000	0.0000
5.000	0.041	0.0019
10.000	0.066	0.0067
15.000	0.069	0.0127
20.000	0.071	0.0187
25.000	0.081	0.0253
30.000	0.095	0.0330
35.000	0.109	0.0419
40.000	0.123	0.0520
49.500	0.139	0.0741
50.000	0.139	0.0753

Deck immersion : 4.570 °
Maximum GZ at : 49.500 °
Equilibrium at : 0.000 °
Area, 0 - 30 : 0.0330 m*rad
Area, 0 - 40 : 0.0520 m*rad
Area,30 - 40 : 0.0190 m*rad
Area, 0 - maxGZ: 0.0741 m*rad
GM : 0.470 m

Heel to starboard side
Applied VCG : 3.170 m
TCG : 0.000 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Conclusion	KGmax (m)
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.139	NOT OK	3.090
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	49.500	OK	3.298
GMMin	Minimum GM		: 0.15 m	0.470	OK	3.489
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.033	NOT OK	3.005
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.052	NOT OK	3.007
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.019	NOT OK	3.060

ß : flooding angle
ð : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : NOT OK

Resulting KGmax .... (m): 3.005
KG (incl. correction) .... (m): 3.170
Intact stability margin .... (m): -0.164

Please note !

-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)

Flood Opening Results

Loading Condition no. : 7 ,Som 6, 10%

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Ref. point		14.6	2.5	4.86	28.28	1.45
2	Lukekarm ved #47	Ref. point		25.2	2.5	4.93	23.52	1.22
3	Forkant luke	Ref. point		34.7	2.5	5.05	20.43	1.08

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Freeboard to Deck

Loading Condition no. : 7 ,Som 6, 10%

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	2.538	2.538
2	-1.300	0.885	5.451	2.501	2.501
3	-0.843	1.388	5.421	2.458	2.458
4	-0.385	1.811	5.391	2.415	2.415
5	0.530	2.392	5.331	2.329	2.329
6	1.625	2.901	5.273	2.240	2.240
7	1.780	2.953	5.265	2.227	2.227
8	2.680	3.256	5.217	2.154	2.154
9	3.755	3.541	5.161	2.067	2.067
10	4.830	3.767	5.105	1.981	1.981
11	5.905	3.955	5.058	1.903	1.903
12	6.980	4.091	5.011	1.825	1.825
13	8.056	4.170	4.983	1.767	1.767
14	9.131	4.215	4.955	1.708	1.708
15	10.206	4.240	4.921	1.644	1.644
16	11.281	4.250	4.888	1.580	1.580
17	11.399	4.250	4.884	1.573	1.573
18	11.400	4.250	4.110	0.799	0.799
19	12.356	4.250	4.098	0.760	0.760
20	13.430	4.250	4.084	0.716	0.716
21	15.580	4.250	4.059	0.629	0.629
22	17.730	4.250	4.037	0.546	0.546
23	19.880	4.250	4.024	0.472	0.472
24	22.030	4.250	4.023	0.410	0.410
25	24.180	4.250	4.053	0.379	0.379
26	26.330	4.250	4.084	0.348	0.348
27	28.480	4.250	4.135	0.338	0.338
28	29.555	4.250	4.166	0.339	0.339
29	30.630	4.250	4.215	0.357	0.357
30	31.705	4.246	4.263	0.375	0.375
31	32.780	4.215	4.317	0.398	0.398
32	33.855	4.182	4.373	0.423	0.423
33	34.930	4.130	4.442	0.462	0.462
34	36.006	4.054	4.518	0.507	0.507
35	37.081	3.933	4.613	0.571	0.571
36	37.900	3.789	4.725	0.660	0.660
37	37.901	4.051	5.851	1.786	1.786
38	38.156	4.031	5.870	1.797	1.797
39	39.230	3.864	5.948	1.845	1.845
40	40.305	3.562	6.041	1.907	1.907
41	41.380	3.195	6.134	1.969	1.969
42	42.455	2.752	6.247	2.051	2.051
43	43.530	2.300	6.359	2.133	2.133
44	44.605	1.386	6.444	2.188	2.188
45	45.500	0.000	6.515	2.233	2.233

Freeboard is vertical distance from deck point to sea at equilibrium.

Loading Condition no. : 8

Avgang Storasund 24,17 t vann i last

FLOATING CONDITION DATA

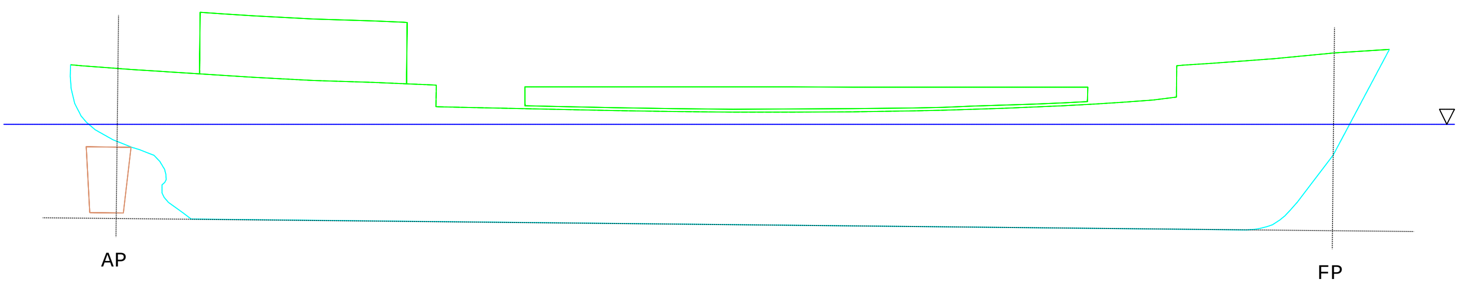
Mean Draught (moulded) :	3.588 m
Trim over Lpp (aft +) :	-0.442 m
List (starboard +) ... :	0.000 °
Draught, AP (moulded) :	3.367 m
Draught, LCF (moulded) :	3.586 m
Draught, FP (moulded) :	3.809 m
Displacement .... :	1028.871 MT
LCB (rel. AP) .... :	22.460 m
VCB (rel. BL) .... :	1.920 m
LCF (rel. AP) .... :	21.545 m
TPC - Immersion ...... :	3.350 MT/cm
Trim Moment .... :	10.046 MT*m/cm

WEIGHT SUMMARY

Cargo	:	675.8 MT
Miscellaneous Mass Loads	:	24.2 MT
Mannskap, Proviant og Stores	:	1.1 MT
Forråd Forliskondisjon	:	8.1 MT
Total DEADWEIGHT	:	709.2 MT

STABILITY DATA/CONTROL

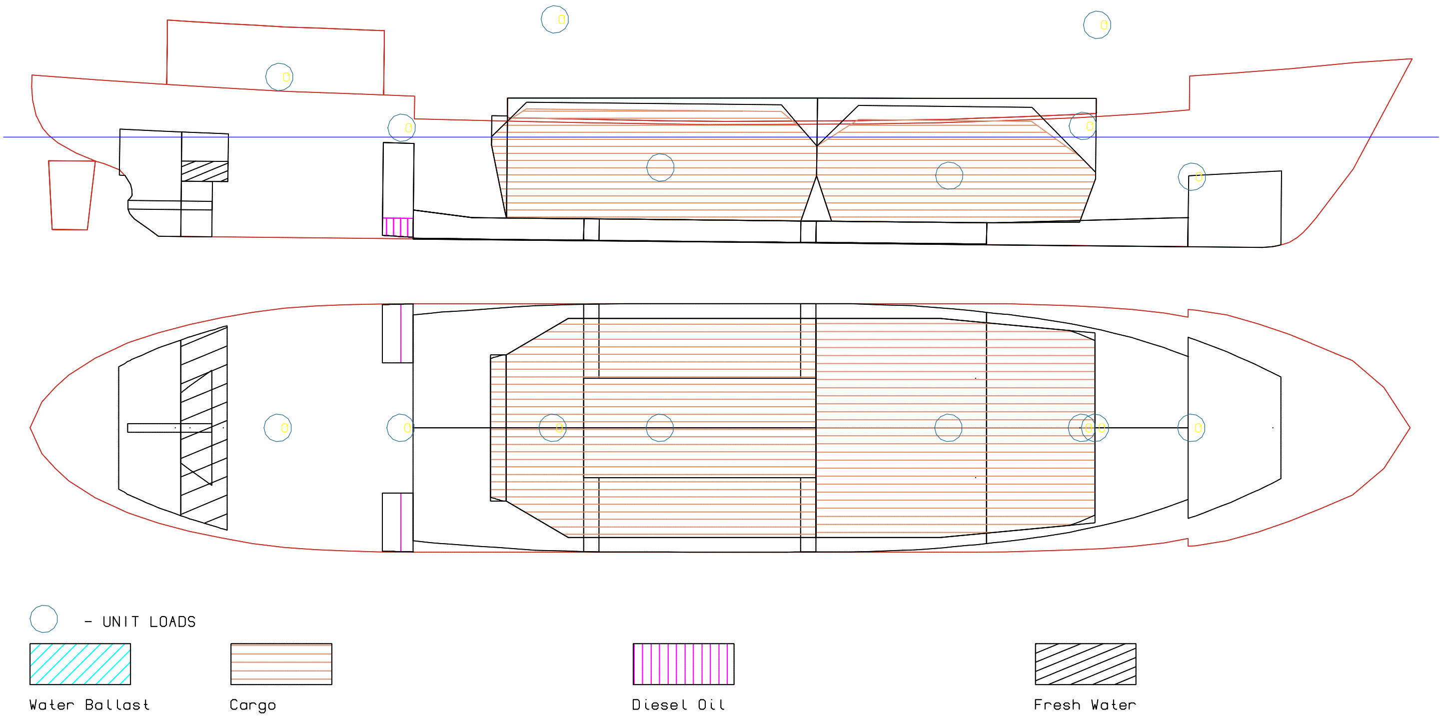
KG (incl. FSC) .... :	2.948 m
Free Surface Correction:	0.023 m
KM (metacentre) ...... :	3.632 m
GM (incl. FSC) .... :	0.684 m



Water Density = 1.025 t/m3

Please note !
-Floating data are based on hydrostatic for upright vessel (zero heel). List is found by use of GM.

Loading Condition no. : 8
Condition Id. text : Avgang Storasund 24,17 t vann i last



WEIGHT LOADS

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)	
1	Lasterom Forut m/tomrom	267.866	87.9	1.5000	25.18	34.72	29.714	0.000	2.351		
2	Lasterom Akter m/tomrom	407.953	94.2	1.7500	14.05	25.18	19.835	0.000	2.530		
3	Mannskap, Proviant og Stores										
-	Mannskap, Proviant	0.600					6.770	0.000	5.500		
-	Stores	0.500					34.270	0.000	4.100		
		1.100					19.270	0.000	4.864		
4	Forråd Forliskondisjon										
-	Brennolje Ving S	0.890	20.0	0.8300	10.34	11.40	10.894	2.834	0.659	0.28	¤
-	Brennolje Ving P	0.890	20.0	0.8300	10.34	11.40	10.894	-2.834	0.659	0.28	¤
-	Dagtank spt. 21-22	0.720					10.970	0.000	3.800		
-	Ferskvann	5.499	41.0	1.0000	3.45	5.04	4.299	0.000	2.314	22.87	¤
-	Smøreolje	0.150					38.020	0.000	2.400		
		8.150					6.950	0.000	2.086		
5	0,8% vann i grus	2.140					29.714	0.000	2.351		
6	5,4% vann i sand	22.030					19.835	0.000	2.530		
7	SHT gr.mask. lcg korr.										
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565		

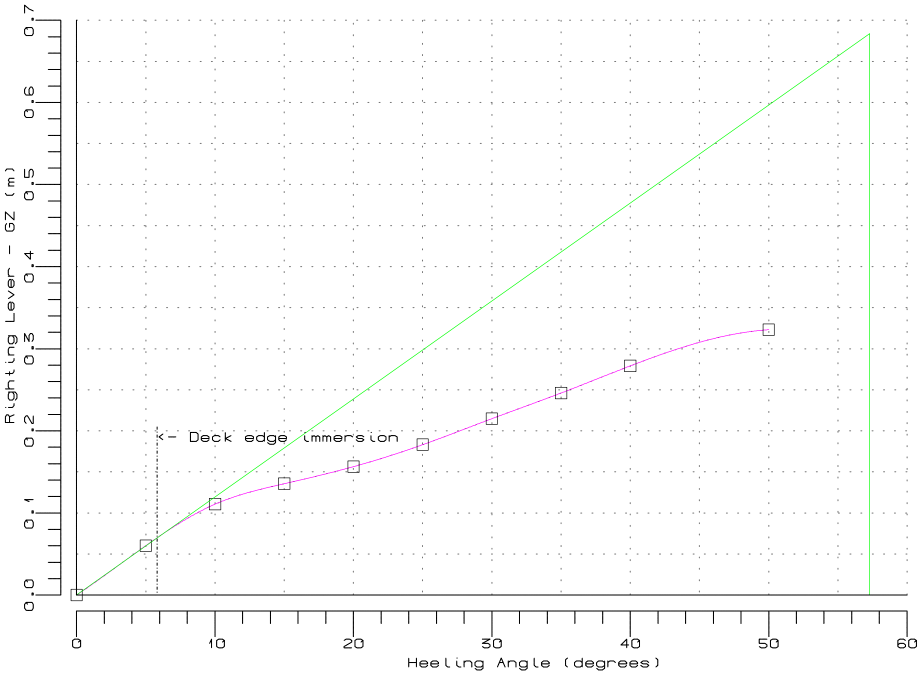
.... to be continued on next page

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	
	DEAD WEIGHT	709.238					22.662	0.000	2.460	
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	1028.877					22.450	0.000	2.925	

¤) The centre of the liquid in these tanks are allowed to shift with heel. The effect from this is incorporated in the calculated GZ-values. The moment of inertia from these tanks are not used to calculate a constant Free Surface Moment applied to artificially raise the VCG applied in the calculations of GZ-values.

Loading Condition no. : 8
Condition Id. text : Avgang Storasund 24,17 t vann i last

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
0.000	0.000	0.0000
5.000	0.060	0.0026
10.000	0.111	0.0102
15.000	0.136	0.0211
20.000	0.156	0.0338
25.000	0.183	0.0486
30.000	0.215	0.0659
35.000	0.246	0.0860
40.000	0.279	0.1089
50.000	0.323	0.1623

Deck immersion : 5.820 °
Maximum GZ at : 50.000 °
Equilibrium at : 0.000 °
Area, 0 - 30 : 0.0659 m*rad
Area, 0 - 40 : 0.1089 m*rad
Area,30 - 40 : 0.0430 m*rad
Area, 0 - maxGZ: 0.1623 m*rad
GM : 0.684 m

Heel to starboard side
Applied VCG : 2.925 m
TCG : 0.000 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Conclusion
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.323	OK
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	50.000	OK
GMMin	Minimum GM		: 0.15 m	0.684	OK
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.066	OK
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.109	OK
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.043	OK

ß : flooding angle
ð : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : OK

Please note !

-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)

FREE SURFACE EFFECTS ON GZ-VALUES

Angle of heel (degrees)	GZ-values with corr. (m)	GZ-values without corr. (m)
0.000	0.000	0.000
5.000	0.060	0.062
10.000	0.111	0.114
15.000	0.136	0.141
20.000	0.156	0.163
25.000	0.183	0.191
30.000	0.215	0.223
35.000	0.246	0.254
40.000	0.279	0.287
50.000	0.323	0.331

The corrected GZ-values are calculated according to the movement of the liquid centers of the compartments listed below.

MOVEMENT OF C.O.G. FOR THE SHIP TOTAL

Movement of center of gravity compared to zero heel and initial trim.

Angle of heel (degrees)	Transversal movement (m)	Vertical movement (m)
0.000	0.000	0.000
5.000	0.002	0.000
10.000	0.004	0.000
15.000	0.006	0.001
20.000	0.007	0.001
25.000	0.008	0.001
30.000	0.008	0.002
35.000	0.008	0.002
40.000	0.009	0.002
50.000	0.009	0.002

Compartment no. 13 Id. text : Brennolje Ving S

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.896	2.836	0.660
5.000	0.890	0.830	10.897	2.864	0.661
10.000	0.890	0.830	10.899	2.895	0.665
15.000	0.890	0.830	10.900	2.929	0.673
20.000	0.890	0.830	10.902	2.968	0.685
25.000	0.890	0.830	10.904	3.012	0.704
30.000	0.890	0.830	10.906	3.064	0.731
35.000	0.890	0.830	10.908	3.125	0.770
40.000	0.890	0.830	10.910	3.198	0.826
50.000	0.890	0.830	10.915	3.393	1.024
Equilibrium:					
0.000	0.000	0.830	0.000	0.000	0.000

Vertical dist. betw. sea and comp. level at equilibrium : 0.000m

Compartment no. 14 Id. text : Brennolje Ving P

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.896	-2.836	0.660
5.000	0.890	0.830	10.895	-2.809	0.661
10.000	0.890	0.830	10.893	-2.785	0.664
15.000	0.890	0.830	10.892	-2.762	0.669
20.000	0.890	0.830	10.891	-2.740	0.676
25.000	0.890	0.830	10.890	-2.719	0.685
30.000	0.890	0.830	10.889	-2.698	0.696
35.000	0.890	0.830	10.888	-2.677	0.710
40.000	0.890	0.830	10.888	-2.655	0.726
50.000	0.890	0.830	10.886	-2.611	0.771
Equilibrium:					
0.000	0.000	0.830	0.000	0.000	0.000

Vertical dist. betw. sea and comp. level at equilibrium : 0.000m

Compartment no. 15 Id. text : Ferskvann

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	5.499	1.000	4.302	0.000	2.315
5.000	5.499	1.000	4.302	0.353	2.330
10.000	5.499	1.000	4.301	0.693	2.375
15.000	5.499	1.000	4.298	1.017	2.446
20.000	5.499	1.000	4.292	1.253	2.520
25.000	5.499	1.000	4.290	1.387	2.575
30.000	5.499	1.000	4.289	1.464	2.614
35.000	5.499	1.000	4.289	1.511	2.644
40.000	5.499	1.000	4.289	1.541	2.667
50.000	5.499	1.000	4.288	1.577	2.702
Equilibrium:					
0.000	0.000	1.000	0.000	0.000	0.000

Vertical dist. betw. sea and comp. level at equilibrium : 0.000m

Flood Opening Results

Loading Condition no. : 8 ,Avgang Storasund 24,17 t vann i last

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Ref. point		14.6	2.5	4.86	26.29	1.34
2	Lukekarm ved #47	Ref. point		25.2	2.5	4.93	25.00	1.30
3	Forkant luke	Ref. point		34.7	2.5	5.05	24.88	1.33

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Freeboard to Deck

Loading Condition no. : 8 ,Avgang Storasund 24,17 t vann i last

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	2.127	2.127
2	-1.300	0.885	5.451	2.097	2.097
3	-0.843	1.388	5.421	2.062	2.062
4	-0.385	1.811	5.391	2.028	2.028
5	0.530	2.392	5.331	1.959	1.959
6	1.625	2.901	5.273	1.889	1.889
7	1.780	2.953	5.265	1.880	1.880
8	2.680	3.256	5.217	1.823	1.823
9	3.755	3.541	5.161	1.756	1.756
10	4.830	3.767	5.105	1.689	1.689
11	5.905	3.955	5.058	1.631	1.631
12	6.980	4.091	5.011	1.573	1.573
13	8.056	4.170	4.983	1.534	1.534
14	9.131	4.215	4.955	1.495	1.495
15	10.206	4.240	4.921	1.451	1.451
16	11.281	4.250	4.888	1.406	1.406
17	11.399	4.250	4.884	1.401	1.401
18	11.400	4.250	4.110	0.627	0.627
19	12.356	4.250	4.098	0.606	0.606
20	13.430	4.250	4.084	0.581	0.581
21	15.580	4.250	4.059	0.533	0.533
22	17.730	4.250	4.037	0.490	0.490
23	19.880	4.250	4.024	0.455	0.455
24	22.030	4.250	4.023	0.432	0.432
25	24.180	4.250	4.053	0.441	0.441
26	26.330	4.250	4.084	0.449	0.449
27	28.480	4.250	4.135	0.479	0.479
28	29.555	4.250	4.166	0.499	0.499
29	30.630	4.250	4.215	0.537	0.537
30	31.705	4.246	4.263	0.574	0.574
31	32.780	4.215	4.317	0.617	0.617
32	33.855	4.182	4.373	0.662	0.662
33	34.930	4.130	4.442	0.721	0.721
34	36.006	4.054	4.518	0.786	0.786
35	37.081	3.933	4.613	0.869	0.869
36	37.900	3.789	4.725	0.973	0.973
37	37.901	4.051	5.851	2.099	2.099
38	38.156	4.031	5.870	2.115	2.115
39	39.230	3.864	5.948	2.182	2.182
40	40.305	3.562	6.041	2.264	2.264
41	41.380	3.195	6.134	2.347	2.347
42	42.455	2.752	6.247	2.448	2.448
43	43.530	2.300	6.359	2.550	2.550
44	44.605	1.386	6.444	2.624	2.624
45	45.500	0.000	6.515	2.686	2.686

Freeboard is vertical distance from deck point to sea at equilibrium.

Loading Condition no. : 11

Ved Tømmerflu FMP 71,46 t vann i last

FLOATING CONDITION DATA

Mean Draught (moulded) :	3.722 m
Trim over Lpp (aft +) :	-0.586 m
List (starboard +) ... :	3.519 °
Draught, AP (moulded) :	3.429 m
Draught, LCF (moulded) :	3.719 m
Draught, FP (moulded) :	4.014 m

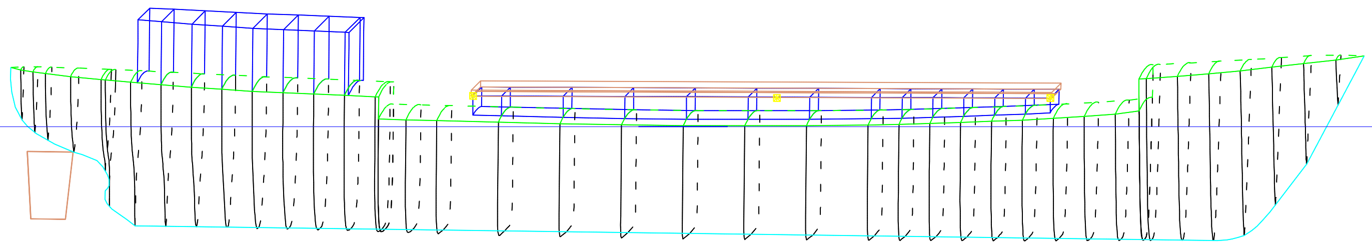
Displacement .... :	1076.160 MT
LCB (rel. AP) .... :	22.556 m
VCB (rel. BL) .... :	1.991 m
LCF (rel. AP) .... :	21.558 m
TPC - Immersion ...... :	3.372 MT/cm
Trim Moment .... :	10.303 MT*m/cm

WEIGHT SUMMARY

Cargo :	700.4 MT
Miscellaneous Mass Loads :	46.9 MT
Mannskap, Proviant og Stores :	1.1 MT
Forråd Forliskondisjon :	8.1 MT
Total DEADWEIGHT :	756.5 MT

STABILITY DATA/CONTROL

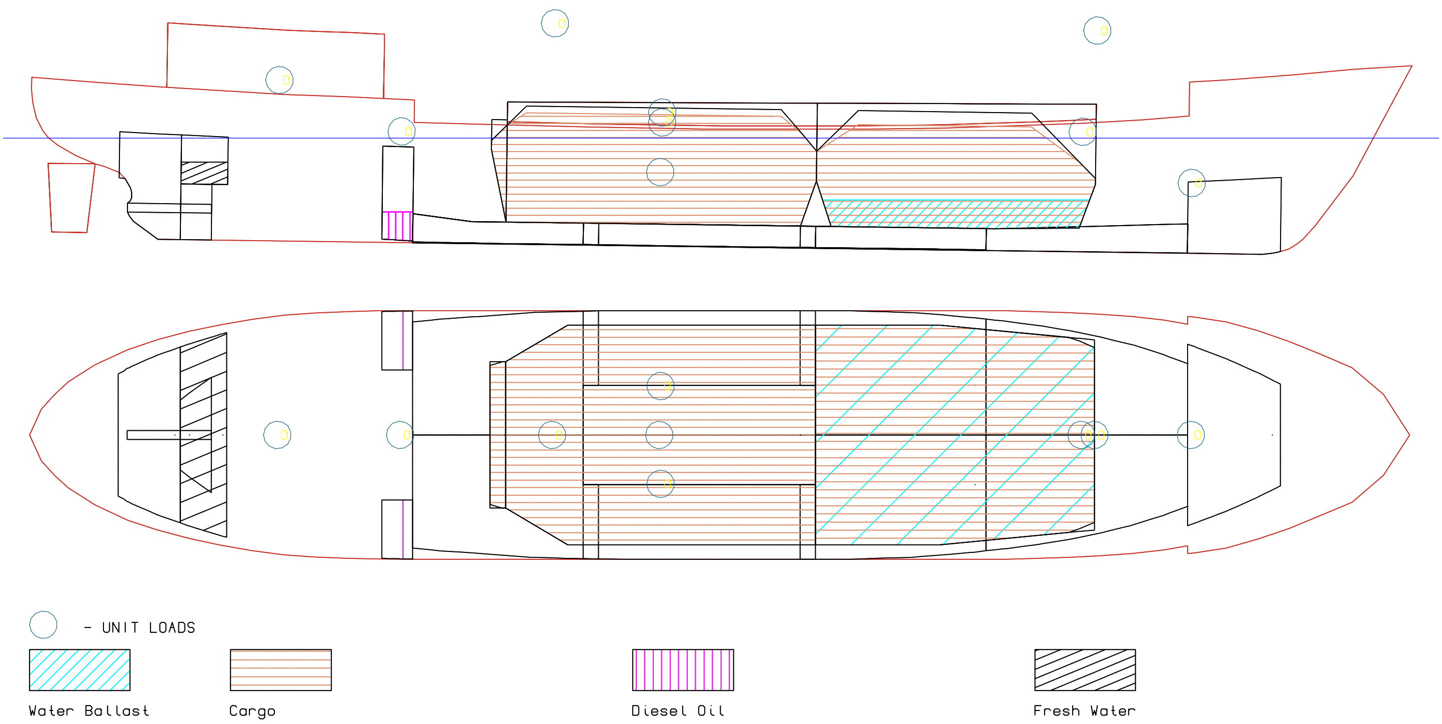
KG (incl. FSC) .... :	3.086 m
Free Surface Correction:	0.201 m
GM (GZ derived) ...... :	0.562 m



Water Density = 1.025 t/m3

Please note !
-Floating data are based on iterations incorporating calculation of exact list (heel giving zero righting lever).
-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the equilibrium calculation.

Loading Condition no. : 11
Condition Id. text : Ved Tømmerflu FMP 71,46 t vann i last



WEIGHT LOADS

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)	
1	Lasterom Forut m/tomrom	270.000	87.9	1.5120	25.18	34.72	29.715	0.000	2.351		
2	Lasterom Akter m/tomrom	407.952	94.2	1.7500	14.05	25.18	19.834	0.000	2.530		
3	Mannskap, Proviant og Stores										
-	Mannskap, Proviant	0.600					6.770	0.000	5.500		
-	Stores	0.500					34.270	0.000	4.100		
		1.100					19.270	0.000	4.864		
4	Forråd Forliskondisjon										
-	Brennolje Ving S	0.890	20.0	0.8300	10.34	11.40	10.897	2.855	0.661	0.28	¤
-	Brennolje Ving P	0.890	20.0	0.8300	10.34	11.40	10.895	-2.817	0.661	0.28	¤
-	Dagtank spt. 21-22	0.720					10.970	0.000	3.800		
-	Ferskvann	5.499	41.0	1.0000	3.45	5.04	4.303	0.249	2.322	22.87	¤
-	Smøreolje	0.150					38.020	0.000	2.400		
		8.150					6.953	0.172	2.091		
5	Lasterom Forut	22.400	21.9	1.0250	25.18	34.72	29.862	0.229	1.255	192.55	¤
6	11,5% vann i sand	46.920					19.835	0.000	2.530		
7	SHT forskyvning av sand										
-	Sand ned babord	-13.190					19.880	-1.670	4.227		

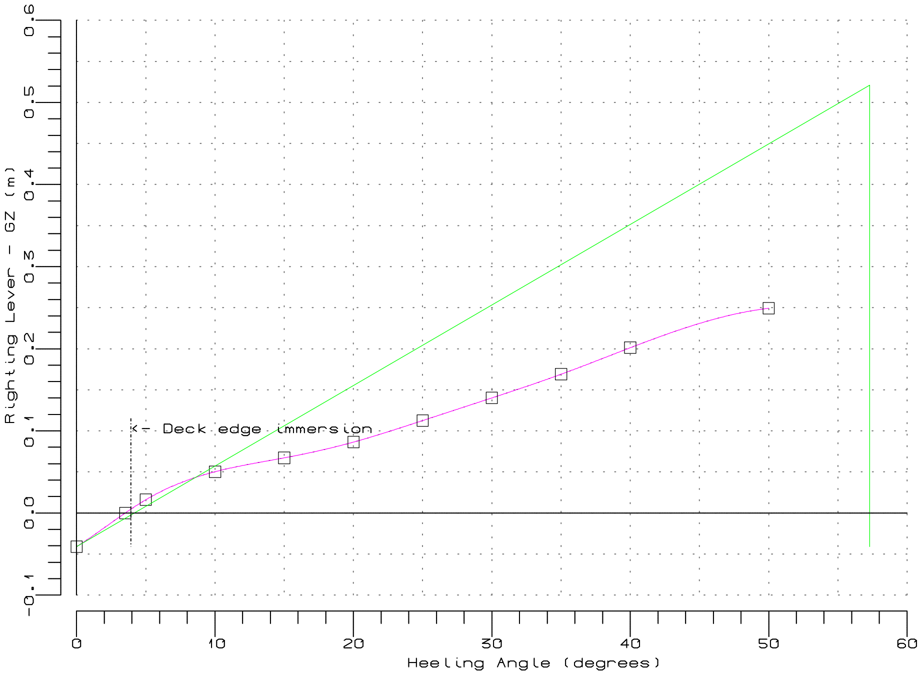
.... to be continued on next page

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
-	Sand opp styrbord	13.190					19.880	1.670	4.567	
		0.000					0.000	0.000	0.000	
8	SHT gr.mask. lcg korr.									
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565	
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	
	DEAD WEIGHT	756.521					22.782	0.067	2.433	
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	1076.160					22.544	0.047	2.886	

¤) The centre of the liquid in these tanks are allowed to shift with heel. The effect from this is incorporated in the calculated GZ-values. The moment of inertia from these tanks are not used to calculate a constant Free Surface Moment applied to artificially raise the VCG applied in the calculations of GZ-values.

Loading Condition no. : 11
Condition Id. text   : Ved Tømmerflu FMP 71,46 t vann i last

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
0.000	-0.041	-0.0013
3.519	0.000	0.0000
5.000	0.016	0.0002
10.000	0.050	0.0033
15.000	0.067	0.0085
20.000	0.086	0.0151
25.000	0.113	0.0237
30.000	0.140	0.0348
35.000	0.169	0.0482
40.000	0.201	0.0644
50.000	0.249	0.1043

Deck immersion :   3.926 °
Maximum GZ at   : 50.000 °
Equilibrium at :   3.519 °
Area, 0 - 30   : 0.0360 m*rad
Area, 0 - 40   : 0.0656 m*rad
Area,30 - 40   : 0.0296 m*rad
Area, 0 - maxGZ: 0.1056 m*rad
GM   :   0.562 m

Heel to starboard side
Applied VCG :   2.886 m
        TCG :   0.041 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Concl-usion
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.249	OK
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	50.000	OK
GMMin	Minimum GM		: 0.15 m	0.562	OK
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.035	NOT OK
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.064	NOT OK
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.030	NOT OK

ß   : flooding angle
ð   : angle for maximum GZ
GZarea : area of righting lever
*)   : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... :   NOT OK

Please note !

The calculations of KGmax are based on upright vessel (TCG=0.0 m). If the actual calculations are based on TCG <> 0.0, the stability conclusion may not correspond with the presented stability margin. The conclusion will anyway be correct as it reflects the actual loading condition.

Please note !

-The calculation of GM is made by finding the tangency line of the GZ-curve for upright vessel (zero heel).
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the calculation of GZ-values. The moment of inertia from these tanks are not contributing to the constant "Free Surface Moment" applied to artificially raise the VCG applied in the calculation of GZ-values

FREE SURFACE EFFECTS ON GZ-VALUES

Angle of heel (degrees)	GZ-values with corr. (m)	GZ-values without corr. (m)
0.000	-0.041	-0.041
5.000	0.016	0.025
10.000	0.050	0.068
15.000	0.067	0.094
20.000	0.086	0.121
25.000	0.113	0.154
30.000	0.140	0.185
35.000	0.169	0.216
40.000	0.201	0.250
50.000	0.249	0.298

The corrected GZ-values are calculated according to the movement of the liquid centers of the compartments listed below.

MOVEMENT OF C.O.G. FOR THE SHIP TOTAL

Movement of center of gravity compared to zero heel and initial trim.

Angle of heel (degrees)	Transversal movement (m)	Vertical movement (m)
0.000	0.000	0.000
5.000	0.009	0.000
10.000	0.017	0.001
15.000	0.027	0.004
20.000	0.035	0.006
25.000	0.041	0.009
30.000	0.046	0.011
35.000	0.049	0.013
40.000	0.051	0.015
50.000	0.054	0.018

Compartment no. 13 Id. text : Brennolje Ving S

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.896	2.836	0.660
5.000	0.890	0.830	10.898	2.864	0.661
10.000	0.890	0.830	10.899	2.895	0.665
15.000	0.890	0.830	10.901	2.929	0.673
20.000	0.890	0.830	10.903	2.968	0.685
25.000	0.890	0.830	10.904	3.012	0.704
30.000	0.890	0.830	10.907	3.064	0.731
35.000	0.890	0.830	10.909	3.125	0.770
40.000	0.890	0.830	10.911	3.198	0.826
50.000	0.890	0.830	10.916	3.393	1.024
Equilibrium:					
3.519	0.890	0.830	10.897	2.855	0.661

Vertical dist. betw. sea and comp. level at equilibrium : 2.717m

Compartment no. 14 Id. text : Brennolje Ving P

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.896	-2.836	0.660
5.000	0.890	0.830	10.895	-2.810	0.661
10.000	0.890	0.830	10.894	-2.785	0.664
15.000	0.890	0.830	10.893	-2.762	0.669
20.000	0.890	0.830	10.892	-2.741	0.676
25.000	0.890	0.830	10.891	-2.719	0.685
30.000	0.890	0.830	10.890	-2.698	0.696
35.000	0.890	0.830	10.889	-2.677	0.710
40.000	0.890	0.830	10.888	-2.655	0.726
50.000	0.890	0.830	10.887	-2.611	0.771
Equilibrium:					
3.519	0.890	0.830	10.895	-2.817	0.661

Vertical dist. betw. sea and comp. level at equilibrium : 2.348m

Compartment no. 15 Id. text : Ferskvann

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	5.499	1.000	4.304	0.000	2.315
5.000	5.499	1.000	4.303	0.353	2.330
10.000	5.499	1.000	4.302	0.693	2.375
15.000	5.500	1.000	4.300	1.017	2.446
20.000	5.500	1.000	4.293	1.253	2.520
25.000	5.499	1.000	4.291	1.387	2.575
30.000	5.499	1.000	4.290	1.464	2.614
35.000	5.499	1.000	4.290	1.511	2.644
40.000	5.499	1.000	4.289	1.541	2.667
50.000	5.499	1.000	4.289	1.577	2.702
Equilibrium:					
3.519	5.499	1.000	4.303	0.249	2.322

Vertical dist. betw. sea and comp. level at equilibrium : 0.824m

Compartment no. 16 Id. text : Lasterom Forut

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	22.399	1.025	29.863	0.000	1.248
5.000	22.399	1.025	29.862	0.326	1.262
10.000	22.399	1.025	29.864	0.658	1.306
15.000	22.399	1.025	29.868	1.022	1.395
20.000	22.398	1.025	29.858	1.367	1.505
25.000	22.399	1.025	29.840	1.630	1.613
30.000	22.398	1.025	29.840	1.813	1.709
35.000	22.398	1.025	29.847	1.943	1.793
40.000	22.399	1.025	29.860	2.041	1.868
50.000	22.399	1.025	29.894	2.173	2.002
Equilibrium:					
3.519	22.399	1.025	29.862	0.229	1.255

Vertical dist. betw. sea and comp. level at equilibrium : 2.116m

Flood Opening Results

Loading Condition no. : 11 ,Ved Tømmerflu FMP 71,46 t vann i last

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Ref. point		14.6	2.5	4.86	23.93	1.07
2	Lukekarm ved #47	Ref. point		25.2	2.5	4.93	22.07	0.99
3	Forkant luke	Ref. point		34.7	2.5	5.05	21.48	0.99

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Results for Reference Points connected to Intact Compartments
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Loading Condition no. : 11 ,Ved Tømmerflu FMP 71,46 t vann i last

No.	Identification text	Type	X (m)	Y (m)	Z (m)	Liquid level (m)
	Lasterom Forut					
2	Lukekarm ved #47	Ref. point	25.180	2.500	4.925	
3	Forkant luke	Ref. point	34.720	2.500	5.050	

Liquid level is vertical distance from reference
point to liquid level in tank at equilibrium.

Freeboard to Deck

Loading Condition no. : 11 ,Ved Tømmerflu FMP 71,46 t vann i last

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	2.060	2.060
2	-1.300	0.885	5.451	1.975	2.083
3	-0.843	1.388	5.421	1.908	2.078
4	-0.385	1.811	5.391	1.846	2.068
5	0.530	2.392	5.331	1.738	2.032
6	1.625	2.901	5.273	1.634	1.990
7	1.780	2.953	5.265	1.621	1.983
8	2.680	3.256	5.217	1.542	1.942
9	3.755	3.541	5.161	1.454	1.889
10	4.830	3.767	5.105	1.370	1.833
11	5.905	3.955	5.058	1.297	1.783
12	6.980	4.091	5.011	1.228	1.730
13	8.056	4.170	4.983	1.180	1.692
14	9.131	4.215	4.955	1.135	1.653
15	10.206	4.240	4.921	1.086	1.606
16	11.281	4.250	4.888	1.037	1.559
17	11.399	4.250	4.884	1.032	1.553
18	11.400	4.250	4.110	0.259	0.781
19	12.356	4.250	4.098	0.234	0.756
20	13.430	4.250	4.084	0.206	0.728
21	15.580	4.250	4.059	0.152	0.673
22	17.730	4.250	4.037	0.101	0.623
23	19.880	4.250	4.024	0.060	0.581
24	22.030	4.250	4.023	0.029	0.551
25	24.180	4.250	4.053	0.031	0.552
26	26.330	4.250	4.084	0.032	0.554
27	28.480	4.250	4.135	0.055	0.576
28	29.555	4.250	4.166	0.071	0.593
29	30.630	4.250	4.215	0.105	0.627
30	31.705	4.246	4.263	0.139	0.661
31	32.780	4.215	4.317	0.180	0.698
32	33.855	4.182	4.373	0.223	0.737
33	34.930	4.130	4.442	0.282	0.789
34	36.006	4.054	4.518	0.348	0.846
35	37.081	3.933	4.613	0.435	0.918
36	37.900	3.789	4.725	0.545	1.010
37	37.901	4.051	5.851	1.652	2.150
38	38.156	4.031	5.870	1.669	2.164
39	39.230	3.864	5.948	1.743	2.217
40	40.305	3.562	6.041	1.840	2.277
41	41.380	3.195	6.134	1.941	2.333
42	42.455	2.752	6.247	2.066	2.403
43	43.530	2.300	6.359	2.191	2.474
44	44.605	1.386	6.444	2.318	2.488
45	45.500	0.000	6.515	2.462	2.462

Freeboard is vertical distance from deck point to sea at equilibrium.

Loading Condition no. : 12

Som 11 sand "mettet" 131,1 t vann i last

FLOATING CONDITION DATA

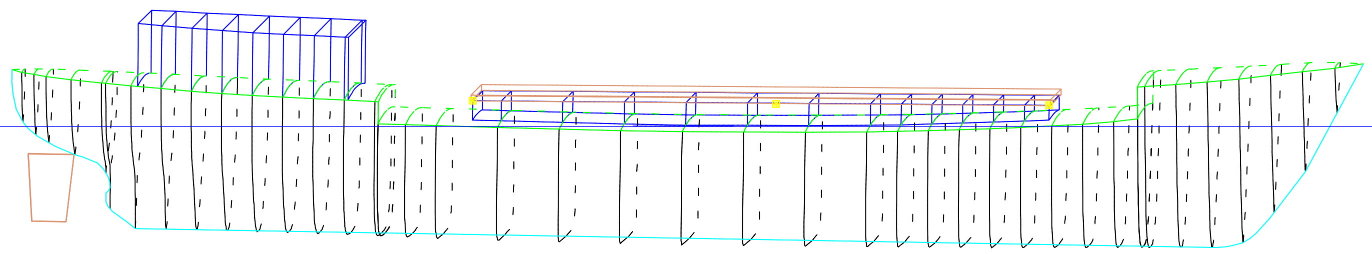
Mean Draught (moulded) :	3.902	m
Trim over Lpp (aft +) :	-0.765	m
List (starboard +) ... :	4.020	°
Draught, AP (moulded) :	3.519	m
Draught, LCF (moulded) :	3.896	m
Draught, FP (moulded) :	4.285	m
Displacement .... :	1135.801	MT
LCB (rel. AP) .... :	22.664	m
VCB (rel. BL) .... :	2.087	m
LCF (rel. AP) .... :	21.432	m
TPC - Immersion ...... :	3.181	MT/cm
Trim Moment .... :	10.343	MT*m/cm

WEIGHT SUMMARY

Cargo :	728.6	MT
Miscellaneous Mass Loads :	78.3	MT
Mannskap, Proviant og Stores :	1.1	MT
Forråd Forliskondisjon :	8.1	MT
Total DEADWEIGHT :	816.2	MT

STABILITY DATA/CONTROL

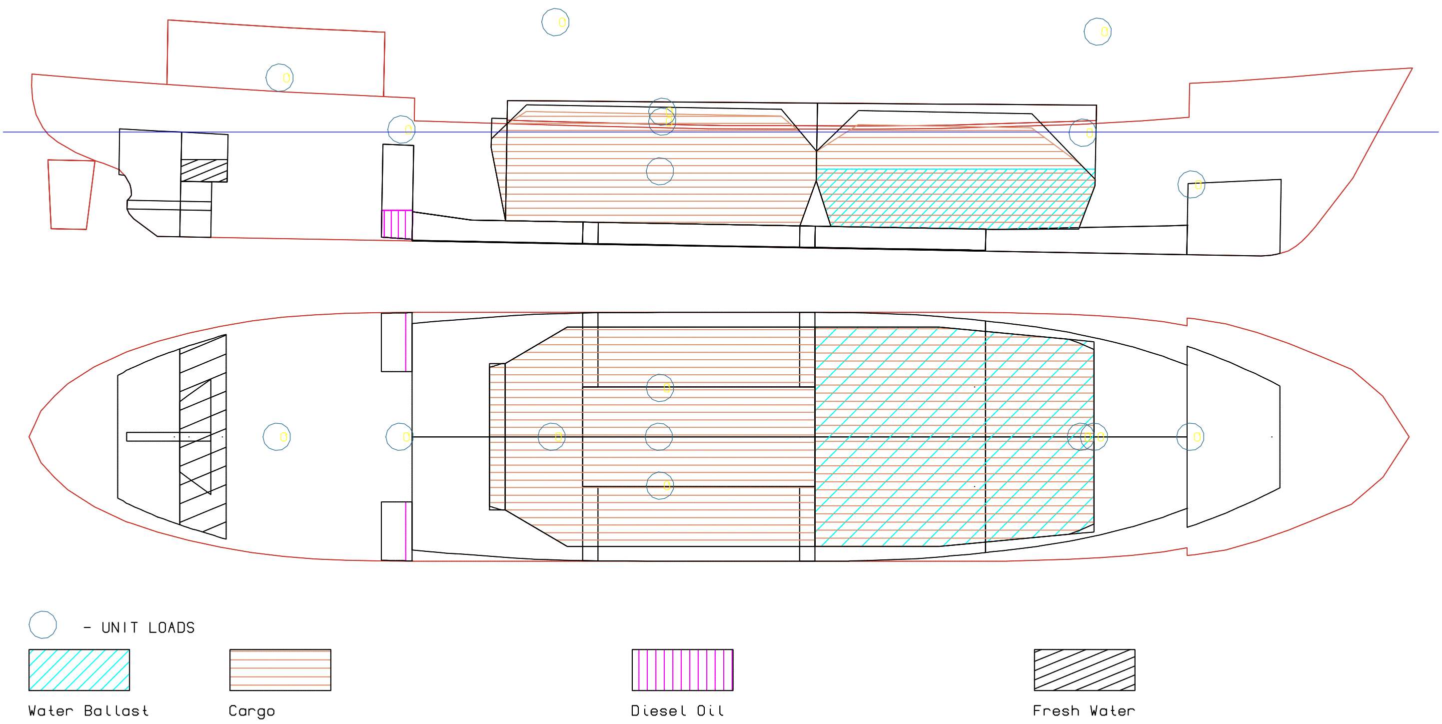
KG (incl. FSC) .... :	3.132	m
Free Surface Correction:	0.271	m
GM (GZ derived) ...... :	0.543	m



Water Density = 1.025 t/m3

Please note !
-Floating data are based on iterations incorporating calculation of exact list (heel giving zero righting lever).
-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the equilibrium calculation.

Loading Condition no. : 12
Condition Id. text : Som 11 sand "mettet" 131,1 t vann i last



WEIGHT LOADS

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)	
1	Lasterom Forut m/tomrom	270.000	87.9	1.5120	25.18	34.72	29.715	0.000	2.351		
2	Lasterom Akter m/tomrom	407.952	94.2	1.7500	14.05	25.18	19.834	0.000	2.530		
3	Mannskap, Proviant og Stores										
-	Mannskap, Proviant	0.600					6.770	0.000	5.500		
-	Stores	0.500					34.270	0.000	4.100		
		1.100					19.270	0.000	4.864		
4	Forråd Forliskondisjon										
-	Brennolje Ving S	0.890	20.0	0.8300	10.34	11.40	10.898	2.858	0.661	0.28	¤
-	Brennolje Ving P	0.890	20.0	0.8300	10.34	11.40	10.896	-2.815	0.661	0.28	¤
-	Dagtank spt. 21-22	0.720					10.970	0.000	3.800		
-	Ferskvann	5.499	41.0	1.0000	3.45	5.04	4.305	0.284	2.325	22.87	¤
-	Smøreolje	0.150					38.020	0.000	2.400		
		8.150					6.954	0.197	2.093		
5	Lasterom Forut	50.650	49.4	1.0250	25.18	34.72	29.863	0.167	1.833	284.19	¤
6	19,2% vann i sand	78.310					19.835	0.000	2.530		
7	SHT forskyvning av sand k 12										
-	Sand ned babord	-14.100					19.880	-1.670	4.227		

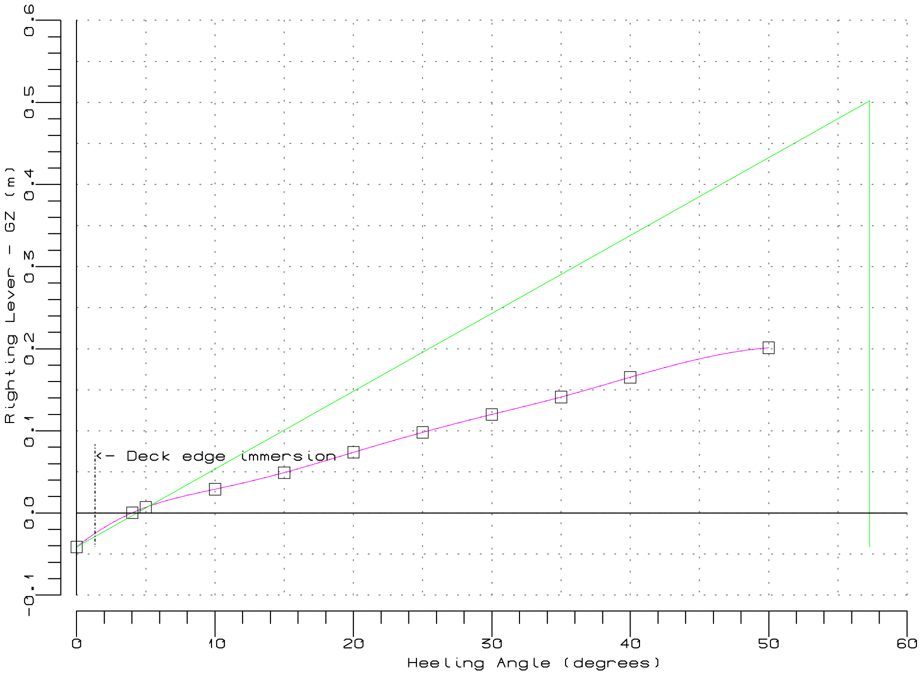
.... to be continued on next page

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
-	Sand opp styrbord	14.100					19.880	1.670	4.567	
		0.000					0.000	0.000	0.000	
8	SHT gr.mask. lcg korr.									
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565	
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	
	DEAD WEIGHT	816.162					22.914	0.070	2.432	
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	1135.801					22.651	0.050	2.861	

¤) The centre of the liquid in these tanks are allowed to shift with heel. The effect from this is incorporated in the calculated GZ-values. The moment of inertia from these tanks are not used to calculate a constant Free Surface Moment applied to artificially raise the VCG applied in the calculations of GZ-values.

Loading Condition no. : 12
Condition Id. text : Som 11 sand "mettet" 131,1 t vann i last

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
0.000	-0.041	-0.0013
4.020	0.000	0.0000
5.000	0.007	0.0001
10.000	0.029	0.0017
15.000	0.049	0.0051
20.000	0.074	0.0104
25.000	0.098	0.0180
30.000	0.120	0.0275
35.000	0.141	0.0389
40.000	0.165	0.0522
50.000	0.201	0.0847

Deck immersion : 1.328 °
Maximum GZ at : 50.000 °
Equilibrium at : 4.020 °
Area, 0 - 30 : 0.0288 m*rad
Area, 0 - 40 : 0.0535 m*rad
Area,30 - 40 : 0.0247 m*rad
Area, 0 - maxGZ: 0.0860 m*rad
GM : 0.543 m

Heel to starboard side
Applied VCG : 2.861 m
TCG : 0.041 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Concl-usion
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.201	OK
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	50.000	OK
GMMin	Minimum GM		: 0.15 m	0.543	OK
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.027	NOT OK
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.052	NOT OK
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.025	NOT OK

ß : flooding angle
ð : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : NOT OK

Please note !

The calculations of GZmax are based on upright vessel (TCG=0.0 m). If the actual calculations are based on TCG <> 0.0, the stability conclusion may not correspond with the presented stability margin. The conclusion will anyway be correct as it reflects the actual loading condition.

Please note !

-The calculation of GM is made by finding the tangency line of the GZ-curve for upright vessel (zero heel).
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the calculation of GZ-values. The moment of inertia from these tanks are not contributing to the constant "Free Surface Moment" applied to artificially raise the VCG applied in the calculation of GZ-values

FREE SURFACE EFFECTS ON GZ-VALUES

Angle of heel (degrees)	GZ-values with corr. (m)	GZ-values without corr. (m)
0.000	-0.041	-0.041
5.000	0.007	0.018
10.000	0.029	0.050
15.000	0.049	0.079
20.000	0.074	0.111
25.000	0.098	0.141
30.000	0.120	0.169
35.000	0.141	0.196
40.000	0.165	0.225
50.000	0.201	0.268

The corrected GZ-values are calculated according to the movement of the liquid centers of the compartments listed below.

MOVEMENT OF C.O.G. FOR THE SHIP TOTAL

Movement of center of gravity compared to zero heel and initial trim.

Angle of heel (degrees)	Transversal movement (m)	Vertical movement (m)
0.000	0.000	0.000
5.000	0.011	0.001
10.000	0.021	0.002
15.000	0.030	0.004
20.000	0.037	0.006
25.000	0.044	0.009
30.000	0.049	0.012
35.000	0.056	0.016
40.000	0.061	0.020
50.000	0.070	0.028

Compartment no. 13 Id. text : Brennolje Ving S

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.897	2.836	0.660
5.000	0.890	0.830	10.898	2.864	0.661
10.000	0.890	0.830	10.900	2.895	0.665
15.000	0.890	0.830	10.902	2.929	0.673
20.000	0.890	0.830	10.903	2.968	0.685
25.000	0.890	0.830	10.905	3.012	0.704
30.000	0.890	0.830	10.908	3.064	0.731
35.000	0.890	0.830	10.910	3.125	0.770
40.000	0.890	0.830	10.913	3.198	0.826
50.000	0.890	0.830	10.918	3.393	1.024
Equilibrium:					
4.020	0.890	0.830	10.898	2.858	0.661

Vertical dist. betw. sea and comp. level at equilibrium : 2.879m

Compartment no. 14 Id. text : Brennolje Ving P

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.897	-2.836	0.660
5.000	0.890	0.830	10.896	-2.810	0.661
10.000	0.890	0.830	10.894	-2.785	0.664
15.000	0.890	0.830	10.893	-2.762	0.669
20.000	0.890	0.830	10.892	-2.741	0.676
25.000	0.890	0.830	10.891	-2.719	0.685
30.000	0.890	0.830	10.890	-2.698	0.696
35.000	0.890	0.830	10.890	-2.677	0.710
40.000	0.890	0.830	10.889	-2.655	0.726
50.000	0.890	0.830	10.888	-2.611	0.771
Equilibrium:					
4.020	0.890	0.830	10.896	-2.815	0.661

Vertical dist. betw. sea and comp. level at equilibrium : 2.458m

Compartment no. 15 Id. text : Ferskvann

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	5.499	1.000	4.305	0.000	2.315
5.000	5.499	1.000	4.304	0.353	2.330
10.000	5.499	1.000	4.303	0.693	2.375
15.000	5.499	1.000	4.301	1.016	2.446
20.000	5.500	1.000	4.294	1.253	2.520
25.000	5.499	1.000	4.292	1.387	2.575
30.000	5.499	1.000	4.291	1.464	2.614
35.000	5.499	1.000	4.291	1.510	2.644
40.000	5.499	1.000	4.290	1.541	2.667
50.000	5.499	1.000	4.290	1.577	2.702
Equilibrium:					
4.020	5.499	1.000	4.305	0.284	2.325

Vertical dist. betw. sea and comp. level at equilibrium : 0.936m

Compartment no. 16 Id. text : Lasterom Forut

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	50.648	1.025	29.862	0.000	1.827
5.000	50.651	1.025	29.863	0.207	1.836
10.000	50.650	1.025	29.871	0.397	1.861
15.000	50.654	1.025	29.881	0.558	1.896
20.000	50.654	1.025	29.893	0.697	1.940
25.000	50.650	1.025	29.908	0.822	1.992
30.000	50.647	1.025	29.925	0.945	2.057
35.000	50.650	1.025	29.947	1.074	2.140
40.000	50.650	1.025	29.962	1.200	2.238
50.000	50.647	1.025	29.975	1.376	2.412
Equilibrium:					
4.020	50.651	1.025	29.863	0.167	1.833

Vertical dist. betw. sea and comp. level at equilibrium : 1.269m

Flood Opening Results

Loading Condition no. : 12 ,Som 11 sand "mettet" 131,1 t vann i last

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Ref. point		14.6	2.5	4.86	20.86	0.89
2	Lukekarm ved #47	Ref. point		25.2	2.5	4.93	18.24	0.78
3	Forkant luke	Ref. point		34.7	2.5	5.05	17.03	0.73

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Results for Reference Points connected to Intact Compartments

Loading Condition no. : 12 ,Som 11 sand "mettet" 131,1 t vann i last

No.	Identification text	Type	X (m)	Y (m)	Z (m)	Liquid level (m)
	Lasterom Forut					
2	Lukekarm ved #47	Ref. point	25.180	2.500	4.925	
3	Forkant luke	Ref. point	34.720	2.500	5.050	

Liquid level is vertical distance from reference
point to liquid level in tank at equilibrium.

Freeboard to Deck

Loading Condition no. : 12 ,Som 11 sand "mettet" 131,1 t vann i last

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	1.974	1.974
2	-1.300	0.885	5.451	1.878	2.002
3	-0.843	1.388	5.421	1.805	2.000
4	-0.385	1.811	5.391	1.738	1.992
5	0.530	2.392	5.331	1.621	1.956
6	1.625	2.901	5.273	1.508	1.915
7	1.780	2.953	5.265	1.494	1.908
8	2.680	3.256	5.217	1.409	1.866
9	3.755	3.541	5.161	1.314	1.811
10	4.830	3.767	5.105	1.224	1.752
11	5.905	3.955	5.058	1.145	1.699
12	6.980	4.091	5.011	1.070	1.643
13	8.056	4.170	4.983	1.017	1.602
14	9.131	4.215	4.955	0.967	1.558
15	10.206	4.240	4.921	0.913	1.507
16	11.281	4.250	4.888	0.860	1.456
17	11.399	4.250	4.884	0.854	1.450
18	11.400	4.250	4.110	0.082	0.678
19	12.356	4.250	4.098	0.053	0.649
20	13.430	4.250	4.084	0.021	0.617
21	15.580	4.250	4.059	-0.043	0.553
22	17.730	4.250	4.037	-0.102	0.494
23	19.880	4.250	4.024	-0.152	0.443
24	22.030	4.250	4.023	-0.192	0.404
25	24.180	4.250	4.053	-0.199	0.397
26	26.330	4.250	4.084	-0.207	0.389
27	28.480	4.250	4.135	-0.193	0.403
28	29.555	4.250	4.166	-0.181	0.415
29	30.630	4.250	4.215	-0.151	0.444
30	31.705	4.246	4.263	-0.122	0.474
31	32.780	4.215	4.317	-0.085	0.506
32	33.855	4.182	4.373	-0.046	0.540
33	34.930	4.130	4.442	0.008	0.587
34	36.006	4.054	4.518	0.071	0.639
35	37.081	3.933	4.613	0.154	0.706
36	37.900	3.789	4.725	0.262	0.794
37	37.901	4.051	5.851	1.367	1.935
38	38.156	4.031	5.870	1.382	1.947
39	39.230	3.864	5.948	1.453	1.995
40	40.305	3.562	6.041	1.548	2.048
41	41.380	3.195	6.134	1.648	2.096
42	42.455	2.752	6.247	1.772	2.158
43	43.530	2.300	6.359	1.897	2.220
44	44.605	1.386	6.444	2.027	2.221
45	45.500	0.000	6.515	2.179	2.179

Freeboard is vertical distance from deck point to sea at equilibrium.

Loading Condition no. : 17

Som 11 med kast i både sand og grus

FLOATING CONDITION DATA

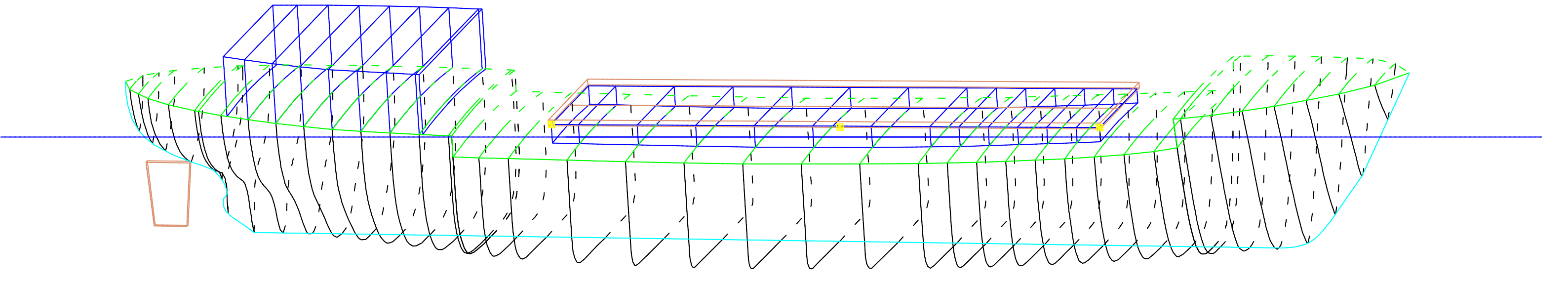
Mean Draught (moulded) :	3.653	m
Trim over Lpp (aft +) :	-0.641	m
List (starboard +) ... :	15.869	°
Draught, AP (moulded) :	3.332	m
Draught, LCF (moulded) :	3.644	m
Draught, FP (moulded) :	3.973	m
Displacement .... :	1076.170	MT
LCB (rel. AP) .... :	22.557	m
VCB (rel. BL) .... :	1.865	m
LCF (rel. AP) .... :	21.200	m
TPC - Immersion ...... :	2.990	MT/cm
Trim Moment .... :	9.932	MT*m/cm

WEIGHT SUMMARY

Cargo :	700.4	MT
Miscellaneous Mass Loads :	46.9	MT
Mannskap, Proviant og Stores :	1.1	MT
Forråd Forliskondisjon :	8.1	MT
Total DEADWEIGHT :	756.5	MT

STABILITY DATA/CONTROL

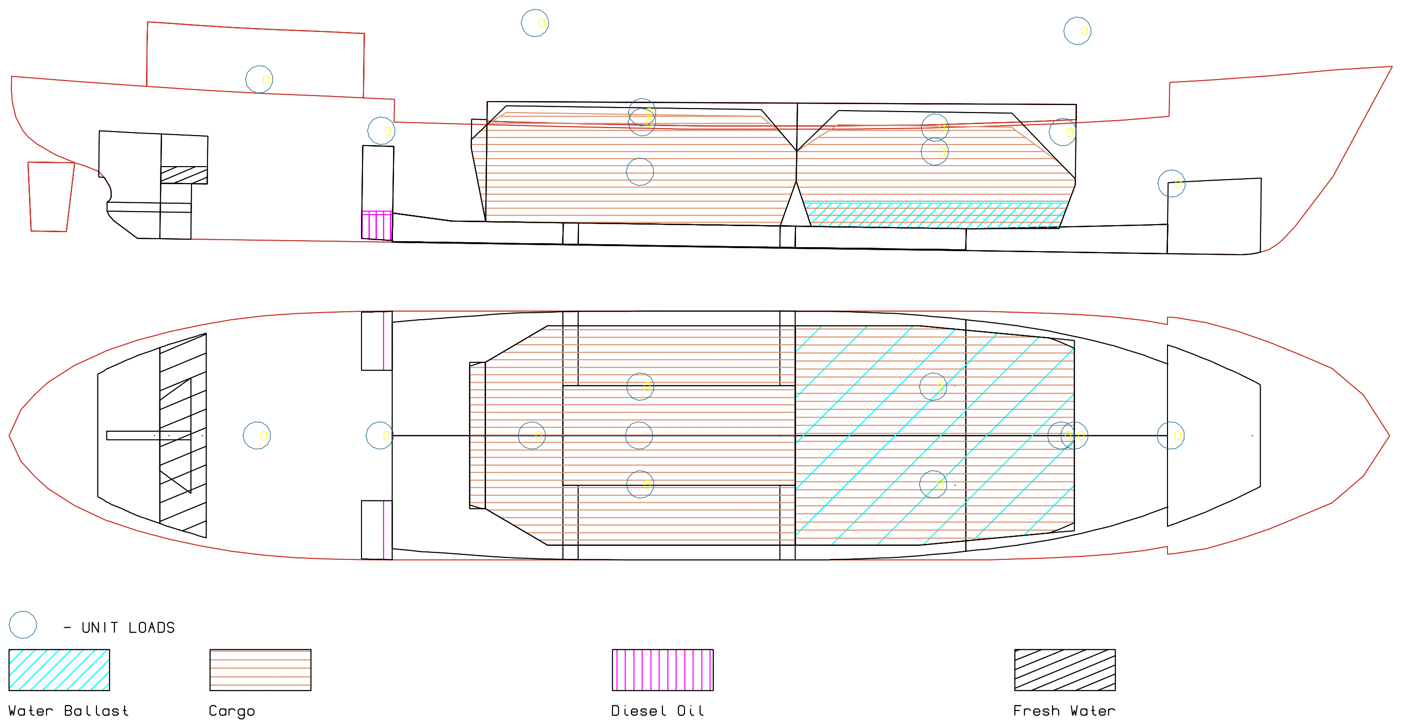
KG (incl. FSC) .... :	3.103	m
Free Surface Correction:	0.201	m
GM (GZ derived) ...... :	0.545	m



Water Density = 1.025 t/m3

Please note !
-Floating data are based on iterations incorporating calculation of exact list (heel giving zero righting lever).
-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the equilibrium calculation.

Loading Condition no. : 17
Condition Id. text : Som 11 med kast i både sand og grus



WEIGHT LOADS

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
1	Lasterom Forut m/tomrom	270.009	87.9	1.5120	25.18	34.72	29.714	0.000	2.351	
2	Lasterom Akter m/tomrom	407.953	94.2	1.7500	14.05	25.18	19.835	0.000	2.530	
3	Mannskap, Proviant og Stores									
-	Mannskap, Proviant	0.600					6.770	0.000	5.500	
-	Stores	0.500					34.270	0.000	4.100	
		1.100					19.270	0.000	4.864	
4	Forråd Forliskondisjon									
-	Brennolje Ving S	0.890	20.0	0.8300	10.34	11.40	10.901	2.936	0.675	0.28 ¤
-	Brennolje Ving P	0.890	20.0	0.8300	10.34	11.40	10.892	-2.759	0.670	0.28 ¤
-	Dagtank spt. 21-22	0.720					10.970	0.000	3.800	
-	Ferskvann	5.499	41.0	1.0000	3.45	5.04	4.298	1.066	2.460	22.87 ¤
-	Smøreolje	0.150					38.020	0.000	2.400	
		8.150					6.950	0.739	2.187	
5	Lasterom Forut	22.400	21.9	1.0250	25.18	34.72	29.869	1.084	1.413	192.55 ¤
6	11,5% vann i sand	46.920					19.835	0.000	2.530	
7	SHT forskyvning av sand									
-	Sand ned babord	-13.190					19.880	-1.670	4.227	

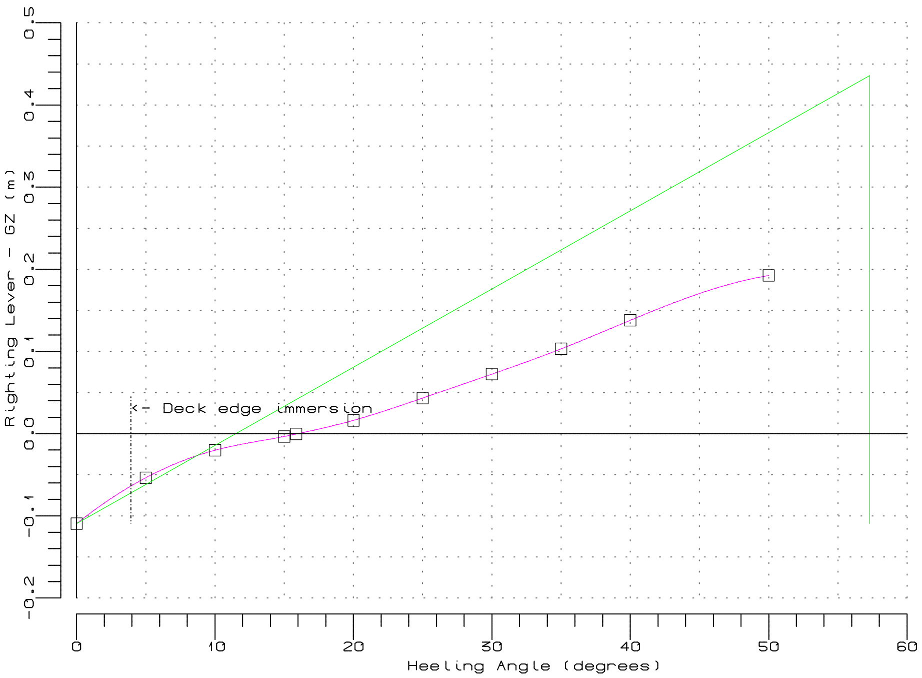
.... to be continued on next page

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
-	Sand opp styrbord	13.190					19.880	1.670	4.567	
		0.000					0.000	0.000	0.000	
8	SHT gr.mask. lcg korr.									
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565	
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	
9	SHT forskyvning av grus									
-	Grus ned babord	-22.070					29.900	-1.670	3.372	
-	Grus opp styrbord	22.070					29.900	1.670	4.188	
		0.000					0.000	0.000	0.000	
	DEAD WEIGHT	756.531					22.783	0.196	2.462	
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	1076.170					22.544	0.138	2.906	

¤) The centre of the liquid in these tanks are allowed to shift with heel. The effect from this is incorporated in the calculated GZ-values. The moment of inertia from these tanks are not used to calculate a constant Free Surface Moment applied to artificially raise the VCG applied in the calculations of GZ-values.

Loading Condition no. : 17
Condition Id. text : Som 11 med kast i både sand og grus

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
0.000	-0.109	-0.0110
5.000	-0.054	-0.0041
10.000	-0.020	-0.0010
15.000	-0.003	0.0000
15.869	0.000	0.0000
20.000	0.016	0.0005
25.000	0.043	0.0031
30.000	0.072	0.0081
35.000	0.103	0.0158
40.000	0.138	0.0263
50.000	0.192	0.0557

Deck immersion : 3.926 °
Maximum GZ at : 50.000 °
Equilibrium at : 15.869 °
Area, 0 - 30 : 0.0192 m*rad
Area, 0 - 40 : 0.0373 m*rad
Area,30 - 40 : 0.0181 m*rad
Area, 0 - maxGZ: 0.0668 m*rad
GM : 0.545 m

Heel to starboard side
Applied VCG : 2.902 m
TCG : 0.109 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Conclusion
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.192	NOT OK
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	50.000	OK
GMMin	Minimum GM		: 0.15 m	0.545	OK
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.008	NOT OK
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.026	NOT OK
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.018	NOT OK

ß : flooding angle
ð : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : NOT OK

Please note !

The calculations of GZmax are based on upright vessel (TCG=0.0 m). If the actual calculations are based on TCG <> 0.0, the stability conclusion may not correspond with the presented stability margin. The conclusion will anyway be correct as it reflects the actual loading condition.

Please note !

-The calculation of GM is made by finding the tangency line of the GZ-curve for upright vessel (zero heel).
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the calculation of GZ-values. The moment of inertia from these tanks are not contributing to the constant "Free Surface Moment" applied to artificially raise the VCG applied in the calculation of GZ-values

FREE SURFACE EFFECTS ON GZ-VALUES

Angle of heel (degrees)	GZ-values with corr. (m)	GZ-values without corr. (m)
0.000	-0.109	-0.109
5.000	-0.054	-0.045
10.000	-0.020	-0.003
15.000	-0.003	0.023
20.000	0.016	0.051
25.000	0.043	0.084
30.000	0.072	0.117
35.000	0.103	0.150
40.000	0.138	0.186
50.000	0.192	0.241

The corrected GZ-values are calculated according to the movement of the liquid centers of the compartments listed below.

MOVEMENT OF C.O.G. FOR THE SHIP TOTAL

Movement of center of gravity compared to zero heel and initial trim.

Angle of heel (degrees)	Transversal movement (m)	Vertical movement (m)
0.000	0.000	0.000
5.000	0.009	0.000
10.000	0.017	0.001
15.000	0.027	0.004
20.000	0.035	0.006
25.000	0.041	0.009
30.000	0.046	0.011
35.000	0.049	0.013
40.000	0.051	0.015
50.000	0.054	0.018

Compartment no. 13 Id. text : Brennolje Ving S

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.896	2.836	0.660
5.000	0.890	0.830	10.898	2.864	0.661
10.000	0.890	0.830	10.899	2.895	0.665
15.000	0.890	0.830	10.901	2.929	0.673
20.000	0.890	0.830	10.903	2.968	0.685
25.000	0.890	0.830	10.904	3.012	0.704
30.000	0.890	0.830	10.907	3.064	0.731
35.000	0.890	0.830	10.909	3.125	0.770
40.000	0.890	0.830	10.911	3.198	0.826
50.000	0.890	0.830	10.916	3.393	1.024
Equilibrium:					
15.869	0.890	0.830	10.901	2.936	0.675

Vertical dist. betw. sea and comp. level at equilibrium : 3.318m

Compartment no. 14 Id. text : Brennolje Ving P

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.896	-2.836	0.660
5.000	0.890	0.830	10.895	-2.810	0.661
10.000	0.890	0.830	10.894	-2.785	0.664
15.000	0.890	0.830	10.893	-2.762	0.669
20.000	0.890	0.830	10.892	-2.741	0.676
25.000	0.890	0.830	10.891	-2.719	0.685
30.000	0.890	0.830	10.890	-2.698	0.696
35.000	0.890	0.830	10.889	-2.677	0.710
40.000	0.890	0.830	10.888	-2.655	0.726
50.000	0.890	0.830	10.887	-2.611	0.771
Equilibrium:					
15.869	0.890	0.830	10.892	-2.759	0.670

Vertical dist. betw. sea and comp. level at equilibrium : 1.674m

Compartment no. 15 Id. text : Ferskvann

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	5.499	1.000	4.304	0.000	2.315
5.000	5.499	1.000	4.303	0.353	2.330
10.000	5.499	1.000	4.302	0.693	2.375
15.000	5.499	1.000	4.300	1.017	2.446
20.000	5.499	1.000	4.293	1.253	2.520
25.000	5.499	1.000	4.291	1.387	2.575
30.000	5.499	1.000	4.290	1.464	2.614
35.000	5.499	1.000	4.290	1.511	2.644
40.000	5.499	1.000	4.289	1.541	2.667
50.000	5.499	1.000	4.289	1.577	2.702
Equilibrium:					
15.869	5.499	1.000	4.298	1.066	2.460

Vertical dist. betw. sea and comp. level at equilibrium : 0.920m

Compartment no. 16 Id. text : Lasterom Forut

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	22.399	1.025	29.863	0.000	1.248
5.000	22.399	1.025	29.862	0.326	1.262
10.000	22.398	1.025	29.864	0.658	1.306
15.000	22.399	1.025	29.869	1.022	1.395
20.000	22.398	1.025	29.858	1.367	1.505
25.000	22.399	1.025	29.840	1.630	1.613
30.000	22.398	1.025	29.840	1.813	1.709
35.000	22.398	1.025	29.847	1.943	1.793
40.000	22.399	1.025	29.860	2.041	1.868
50.000	22.399	1.025	29.894	2.173	2.002
Equilibrium:					
15.869	22.399	1.025	29.869	1.084	1.413

Vertical dist. betw. sea and comp. level at equilibrium : 2.158m

Flood Opening Results

Loading Condition no. : 17 ,Som 11 med kast i både sand og grus

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Ref. point		14.6	2.5	4.86	23.93	0.44
2	Lukekarm ved #47	Ref. point		25.2	2.5	4.93	22.07	0.35
3	Forkant luke	Ref. point		34.7	2.5	5.05	21.48	0.33

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Results for Reference Points connected to Intact Compartments

Loading Condition no. : 17 ,Som 11 med kast i både sand og grus

No.	Identification text	Type	X (m)	Y (m)	Z (m)	Liquid level (m)
	Lasterom Forut					
2	Lukekarm ved #47	Ref. point	25.180	2.500	4.925	
3	Forkant luke	Ref. point	34.720	2.500	5.050	

Liquid level is vertical distance from reference
point to liquid level in tank at equilibrium.

Freeboard to Deck

Loading Condition no. : 17 ,Som 11 med kast i både sand og grus

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	1.961	1.961
2	-1.300	0.885	5.451	1.688	2.172
3	-0.843	1.388	5.421	1.515	2.274
4	-0.385	1.811	5.391	1.364	2.354
5	0.530	2.392	5.331	1.134	2.442
6	1.625	2.901	5.273	0.923	2.509
7	1.780	2.953	5.265	0.898	2.513
8	2.680	3.256	5.217	0.756	2.537
9	3.755	3.541	5.161	0.609	2.545
10	4.830	3.767	5.105	0.477	2.537
11	5.905	3.955	5.058	0.365	2.527
12	6.980	4.091	5.011	0.267	2.504
13	8.056	4.170	4.983	0.202	2.482
14	9.131	4.215	4.955	0.147	2.452
15	10.206	4.240	4.921	0.092	2.411
16	11.281	4.250	4.888	0.041	2.365
17	11.399	4.250	4.884	0.036	2.360
18	11.400	4.250	4.110	-0.709	1.615
19	12.356	4.250	4.098	-0.734	1.590
20	13.430	4.250	4.084	-0.763	1.561
21	15.580	4.250	4.059	-0.819	1.505
22	17.730	4.250	4.037	-0.872	1.452
23	19.880	4.250	4.024	-0.916	1.408
24	22.030	4.250	4.023	-0.949	1.375
25	24.180	4.250	4.053	-0.951	1.373
26	26.330	4.250	4.084	-0.954	1.370
27	28.480	4.250	4.135	-0.936	1.388
28	29.555	4.250	4.166	-0.922	1.402
29	30.630	4.250	4.215	-0.891	1.433
30	31.705	4.246	4.263	-0.859	1.463
31	32.780	4.215	4.317	-0.815	1.490
32	33.855	4.182	4.373	-0.768	1.519
33	34.930	4.130	4.442	-0.703	1.556
34	36.006	4.054	4.518	-0.624	1.592
35	37.081	3.933	4.613	-0.517	1.634
36	37.900	3.789	4.725	-0.381	1.691
37	37.901	4.051	5.851	0.630	2.845
38	38.156	4.031	5.870	0.650	2.854
39	39.230	3.864	5.948	0.755	2.868
40	40.305	3.562	6.041	0.911	2.859
41	41.380	3.195	6.134	1.085	2.832
42	42.455	2.752	6.247	1.299	2.803
43	43.530	2.300	6.359	1.515	2.772
44	44.605	1.386	6.444	1.831	2.588
45	45.500	0.000	6.515	2.265	2.265

Freeboard is vertical distance from deck point to sea at equilibrium.

Loading Condition no. : 18

Som 11 med kast kun i grus

FLOATING CONDITION DATA

Mean Draught (moulded) :	3.708	m
Trim over Lpp (aft +) :	-0.588	m
List (starboard +) ... :	6.416	°
Draught, AP (moulded) :	3.414	m
Draught, LCF (moulded) :	3.705	m
Draught, FP (moulded) :	4.002	m

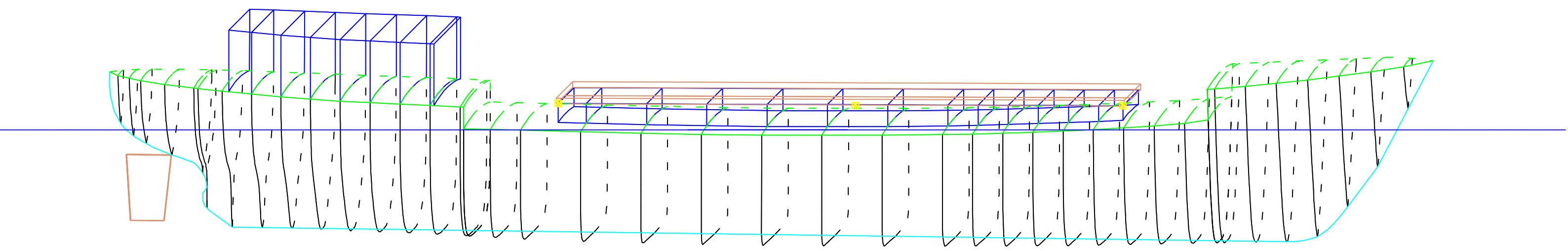
Displacement .... :	1076.170	MT
LCB (rel. AP) .... :	22.556	m
VCB (rel. BL) .... :	1.975	m
LCF (rel. AP) .... :	21.474	m
TPC - Immersion ...... :	3.221	MT/cm
Trim Moment .... :	10.222	MT*m/cm

WEIGHT SUMMARY

Cargo	:	700.4	MT
Miscellaneous Mass Loads	:	46.9	MT
Mannskap, Proviant og Stores	:	1.1	MT
Forråd Forliskondisjon	:	8.1	MT
Total DEADWEIGHT	:	756.5	MT

STABILITY DATA/CONTROL

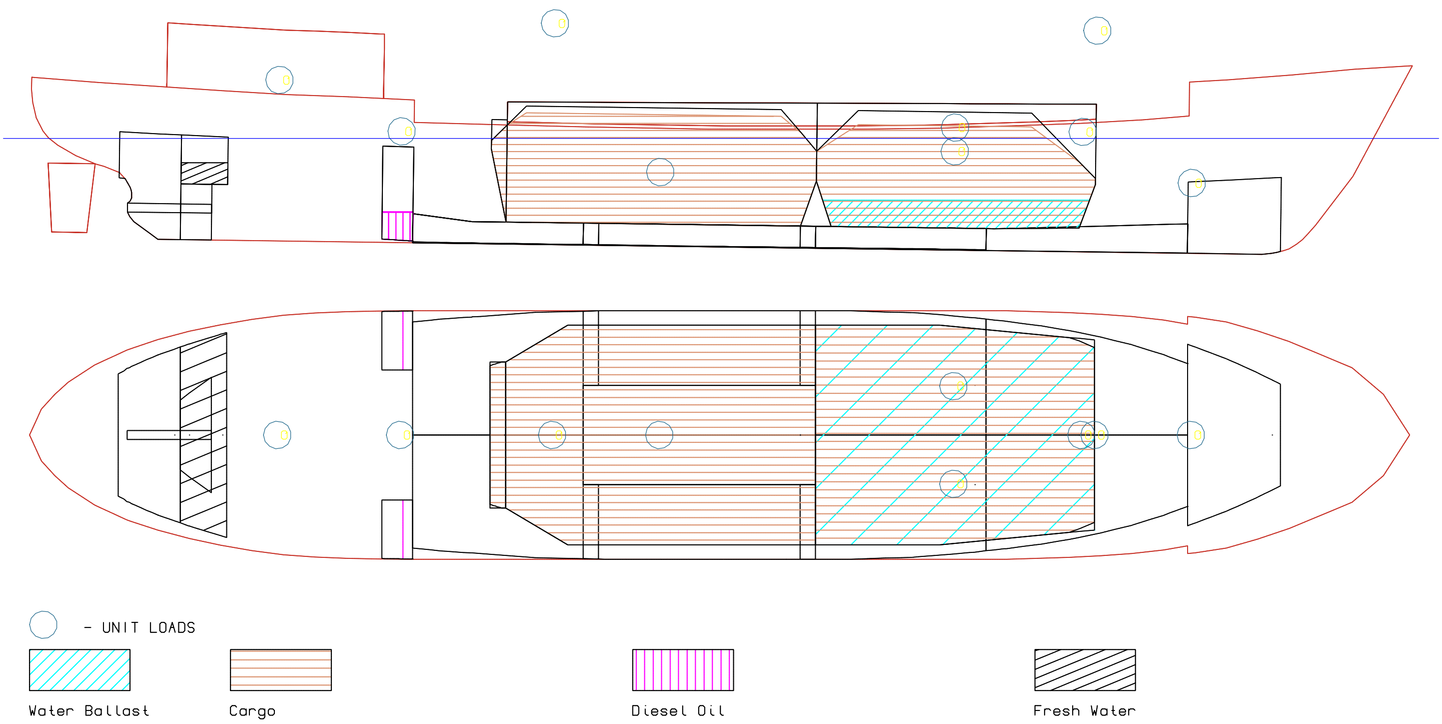
KG (incl. FSC) .... :	3.099	m
Free Surface Correction:	0.201	m
GM (GZ derived) ...... :	0.549	m



Water Density = 1.025 t/m3

Please note !
-Floating data are based on iterations incorporating calculation of exact list (heel giving zero righting lever).
-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the equilibrium calculation.

Loading Condition no. : 18
Condition Id. text : Som 11 med kast kun i grus



WEIGHT LOADS

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
1	Lasterom Forut m/tomrom	270.009	87.9	1.5120	25.18	34.72	29.714	0.000	2.351	
2	Lasterom Akter m/tomrom	407.953	94.2	1.7500	14.05	25.18	19.835	0.000	2.530	
3	Mannskap, Proviant og Stores									
-	Mannskap, Proviant	0.600					6.770	0.000	5.500	
-	Stores	0.500					34.270	0.000	4.100	
		1.100					19.270	0.000	4.864	
4	Forråd Forliskondisjon									
-	Brennolje Ving S	0.890	20.0	0.8300	10.34	11.40	10.898	2.872	0.662	0.28 ¤
-	Brennolje Ving P	0.890	20.0	0.8300	10.34	11.40	10.895	-2.802	0.662	0.28 ¤
-	Dagtank spt. 21-22	0.720					10.970	0.000	3.800	
-	Ferskvann	5.499	41.0	1.0000	3.45	5.04	4.303	0.451	2.340	22.87 ¤
-	Smøreolje	0.150					38.020	0.000	2.400	
		8.150					6.953	0.312	2.103	
5	Lasterom Forut	22.400	21.9	1.0250	25.18	34.72	29.863	0.419	1.272	192.55 ¤
6	11,5% vann i sand	46.920					19.835	0.000	2.530	
7	SHT forskyvning av grus									
-	Grus ned babord	-22.070					29.900	-1.670	3.372	

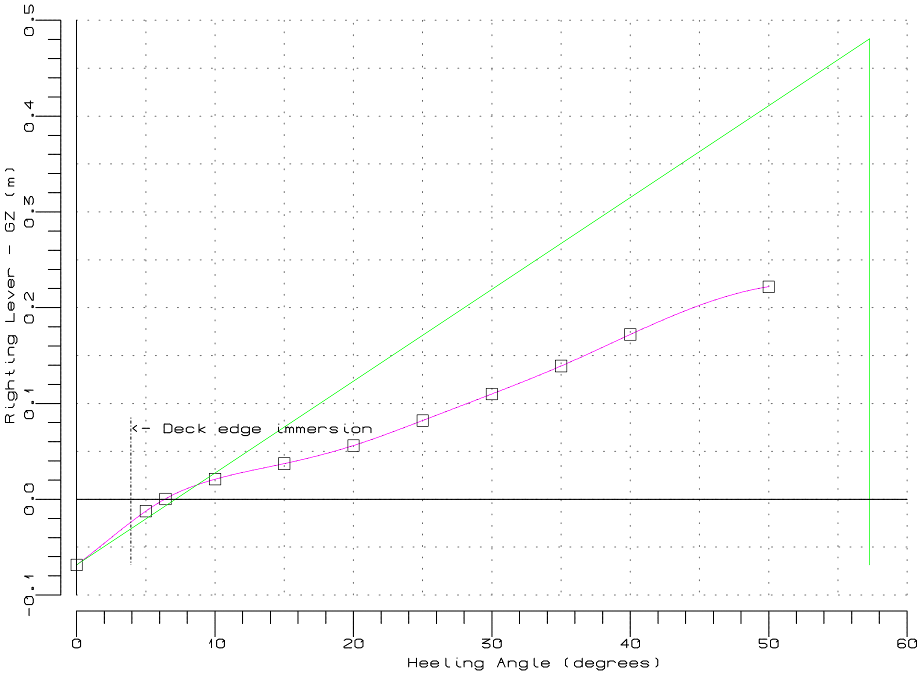
.... to be continued on next page

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
-	Grus opp styrbord	22.070					29.900	1.670	4.188	
		0.000					0.000	0.000	0.000	
8	SHT gr.mask. lcg korr.									
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565	
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	
	DEAD WEIGHT	756.531					22.782	0.113	2.451	
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	1076.170					22.544	0.080	2.899	

¤) The centre of the liquid in these tanks are allowed to shift with heel. The effect from this is incorporated in the calculated GZ-values. The moment of inertia from these tanks are not used to calculate a constant Free Surface Moment applied to artificially raise the VCG applied in the calculations of GZ-values.

Loading Condition no. : 18
Condition Id. text : Som 11 med kast kun i grus

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
0.000	-0.068	-0.0037
5.000	-0.012	-0.0001
6.416	0.000	0.0000
10.000	0.021	0.0007
15.000	0.037	0.0033
20.000	0.056	0.0073
25.000	0.082	0.0133
30.000	0.110	0.0217
35.000	0.139	0.0325
40.000	0.172	0.0461
50.000	0.222	0.0811

Deck immersion : 3.926 °
Maximum GZ at : 50.000 °
Equilibrium at : 6.416 °
Area, 0 - 30 : 0.0254 m*rad
Area, 0 - 40 : 0.0498 m*rad
Area,30 - 40 : 0.0244 m*rad
Area, 0 - maxGZ: 0.0848 m*rad
GM : 0.549 m

Heel to starboard side
Applied VCG : 2.898 m
TCG : 0.068 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Concl-usion
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.222	OK
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	50.000	OK
GMMin	Minimum GM		: 0.15 m	0.549	OK
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.022	NOT OK
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.046	NOT OK
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.024	NOT OK

ß : flooding angle
ð : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : NOT OK

Please note !

The calculation of Kemax are based on upright vessel (TCG=0.0 m). If the actual calculations are based on TCG <> 0.0, the stability conclusion may not correspond with the presented stability margin. The conclusion will anyway be correct as it reflects the actual loading condition.

Please note !

-The calculation of GM is made by finding the tangency line of the GZ-curve for upright vessel (zero heel).
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the calculation of GZ-values. The moment of inertia from these tanks are not contributing to the constant "Free Surface Moment" applied to artificially raise the VCG applied in the calculation of GZ-values

FREE SURFACE EFFECTS ON GZ-VALUES

Angle of heel (degrees)	GZ-values with corr. (m)	GZ-values without corr. (m)
0.000	-0.068	-0.068
5.000	-0.012	-0.004
10.000	0.021	0.038
15.000	0.037	0.064
20.000	0.056	0.091
25.000	0.082	0.123
30.000	0.110	0.155
35.000	0.139	0.186
40.000	0.172	0.220
50.000	0.222	0.270

The corrected GZ-values are calculated according to the movement of the liquid centers of the compartments listed below.

MOVEMENT OF C.O.G. FOR THE SHIP TOTAL

Movement of center of gravity compared to zero heel and initial trim.

Angle of heel (degrees)	Transversal movement (m)	Vertical movement (m)
0.000	0.000	0.000
5.000	0.009	0.000
10.000	0.017	0.001
15.000	0.027	0.004
20.000	0.035	0.006
25.000	0.041	0.009
30.000	0.046	0.011
35.000	0.049	0.013
40.000	0.051	0.015
50.000	0.054	0.018

Compartment no. 13 Id. text : Brennolje Ving S

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.896	2.836	0.660
5.000	0.890	0.830	10.898	2.864	0.661
10.000	0.890	0.830	10.899	2.895	0.665
15.000	0.890	0.830	10.901	2.929	0.673
20.000	0.890	0.830	10.903	2.968	0.685
25.000	0.890	0.830	10.904	3.012	0.704
30.000	0.890	0.830	10.907	3.064	0.731
35.000	0.890	0.830	10.909	3.125	0.770
40.000	0.890	0.830	10.911	3.198	0.826
50.000	0.890	0.830	10.916	3.393	1.024
Equilibrium:					
6.416	0.890	0.830	10.898	2.872	0.662

Vertical dist. betw. sea and comp. level at equilibrium : 2.860m

Compartment no. 14 Id. text : Brennolje Ving P

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.896	-2.836	0.660
5.000	0.890	0.830	10.895	-2.810	0.661
10.000	0.890	0.830	10.894	-2.785	0.664
15.000	0.890	0.830	10.893	-2.762	0.669
20.000	0.890	0.830	10.892	-2.741	0.676
25.000	0.890	0.830	10.891	-2.719	0.685
30.000	0.890	0.830	10.890	-2.698	0.696
35.000	0.890	0.830	10.889	-2.677	0.710
40.000	0.890	0.830	10.888	-2.655	0.726
50.000	0.890	0.830	10.887	-2.611	0.771
Equilibrium:					
6.416	0.890	0.830	10.895	-2.802	0.662

Vertical dist. betw. sea and comp. level at equilibrium : 2.188m

Compartment no. 15 Id. text : Ferskvann

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	5.499	1.000	4.304	0.000	2.315
5.000	5.499	1.000	4.303	0.353	2.330
10.000	5.499	1.000	4.302	0.693	2.375
15.000	5.499	1.000	4.300	1.017	2.446
20.000	5.499	1.000	4.293	1.253	2.520
25.000	5.499	1.000	4.291	1.387	2.575
30.000	5.499	1.000	4.290	1.464	2.614
35.000	5.499	1.000	4.290	1.511	2.644
40.000	5.499	1.000	4.289	1.541	2.667
50.000	5.499	1.000	4.289	1.577	2.702
Equilibrium:					
6.416	5.499	1.000	4.303	0.451	2.340

Vertical dist. betw. sea and comp. level at equilibrium : 0.834m

Compartment no. 16 Id. text : Lasterom Forut

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	22.399	1.025	29.863	0.000	1.248
5.000	22.399	1.025	29.862	0.326	1.262
10.000	22.398	1.025	29.864	0.658	1.306
15.000	22.399	1.025	29.869	1.022	1.395
20.000	22.398	1.025	29.858	1.367	1.505
25.000	22.399	1.025	29.840	1.630	1.613
30.000	22.398	1.025	29.840	1.813	1.709
35.000	22.398	1.025	29.847	1.943	1.793
40.000	22.399	1.025	29.860	2.041	1.868
50.000	22.399	1.025	29.894	2.173	2.002
Equilibrium:					
6.416	22.399	1.025	29.863	0.419	1.272

Vertical dist. betw. sea and comp. level at equilibrium : 2.115m

Flood Opening Results

Loading Condition no. : 18 ,Som 11 med kast kun i grus

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Ref. point		14.6	2.5	4.86	23.93	0.93
2	Lukekarm ved #47	Ref. point		25.2	2.5	4.93	22.07	0.86
3	Forkant luke	Ref. point		34.7	2.5	5.05	21.48	0.86

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Results for Reference Points connected to Intact Compartments

Loading Condition no. : 18 ,Som 11 med kast kun i grus

No.	Identification text	Type	X (m)	Y (m)	Z (m)	Liquid level (m)
	Lasterom Forut					
2	Lukekarm ved #47	Ref. point	25.180	2.500	4.925	
3	Forkant luke	Ref. point	34.720	2.500	5.050	

Liquid level is vertical distance from reference point to liquid level in tank at equilibrium.

Freeboard to Deck

Loading Condition no. : 18 ,Som 11 med kast kun i grus

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	2.051	2.051
2	-1.300	0.885	5.451	1.921	2.118
3	-0.843	1.388	5.421	1.829	2.139
4	-0.385	1.811	5.391	1.745	2.150
5	0.530	2.392	5.331	1.609	2.143
6	1.625	2.901	5.273	1.479	2.127
7	1.780	2.953	5.265	1.463	2.123
8	2.680	3.256	5.217	1.370	2.097
9	3.755	3.541	5.161	1.268	2.059
10	4.830	3.767	5.105	1.172	2.014
11	5.905	3.955	5.058	1.090	1.974
12	6.980	4.091	5.011	1.014	1.928
13	8.056	4.170	4.983	0.962	1.894
14	9.131	4.215	4.955	0.915	1.857
15	10.206	4.240	4.921	0.864	1.812
16	11.281	4.250	4.888	0.815	1.765
17	11.399	4.250	4.884	0.810	1.760
18	11.400	4.250	4.110	0.041	0.991
19	12.356	4.250	4.098	0.016	0.966
20	13.430	4.250	4.084	-0.012	0.938
21	15.580	4.250	4.059	-0.067	0.883
22	17.730	4.250	4.037	-0.117	0.833
23	19.880	4.250	4.024	-0.159	0.791
24	22.030	4.250	4.023	-0.189	0.761
25	24.180	4.250	4.053	-0.188	0.762
26	26.330	4.250	4.084	-0.187	0.763
27	28.480	4.250	4.135	-0.165	0.785
28	29.555	4.250	4.166	-0.149	0.801
29	30.630	4.250	4.215	-0.115	0.835
30	31.705	4.246	4.263	-0.080	0.868
31	32.780	4.215	4.317	-0.038	0.903
32	33.855	4.182	4.373	0.006	0.941
33	34.930	4.130	4.442	0.067	0.990
34	36.006	4.054	4.518	0.136	1.042
35	37.081	3.933	4.613	0.229	1.108
36	37.900	3.789	4.725	0.346	1.193
37	37.901	4.051	5.851	1.435	2.340
38	38.156	4.031	5.870	1.452	2.353
39	39.230	3.864	5.948	1.534	2.398
40	40.305	3.562	6.041	1.646	2.442
41	41.380	3.195	6.134	1.765	2.479
42	42.455	2.752	6.247	1.912	2.527
43	43.530	2.300	6.359	2.059	2.573
44	44.605	1.386	6.444	2.232	2.541
45	45.500	0.000	6.515	2.445	2.445

Freeboard is vertical distance from deck point to sea at equilibrium.

Loading Condition no. : 24

Som 23 med "tank" over forsk. sand

FLOATING CONDITION DATA

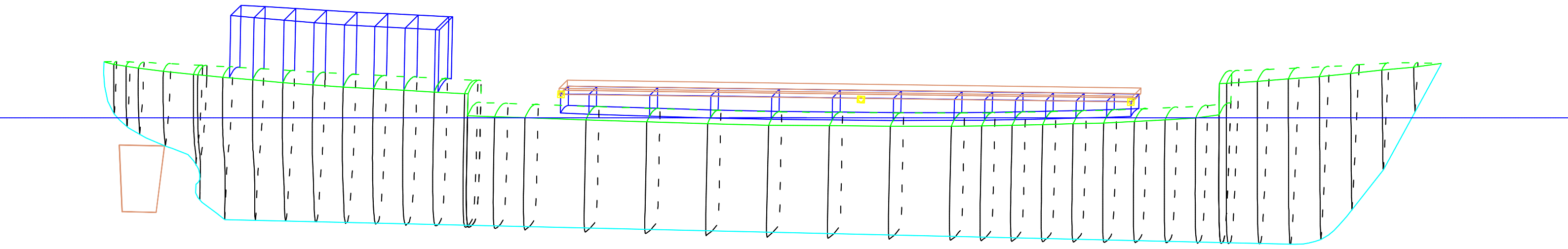
Mean Draught (moulded) :	4.038	m
Trim over Lpp (aft +) :	-1.008	m
List (starboard +) ... :	3.150	°
Draught, AP (moulded) :	3.534	m
Draught, LCF (moulded) :	4.027	m
Draught, FP (moulded) :	4.542	m
Displacement .... :	1177.611	MT
LCB (rel. AP) .... :	22.834	m
VCB (rel. BL) .... :	2.161	m
LCF (rel. AP) .... :	21.285	m
TPC - Immersion ...... :	3.053	MT/cm
Trim Moment .... :	10.305	MT*m/cm

WEIGHT SUMMARY

Cargo	:	754.5	MT
Miscellaneous Liquid Loads	:	28.7	MT
Miscellaneous Mass Loads	:	78.3	MT
Mannskap, Proviant og Stores	:	1.1	MT
Forråd Forliskondisjon	:	8.1	MT
Total DEADWEIGHT	:	870.8	MT

STABILITY DATA/CONTROL

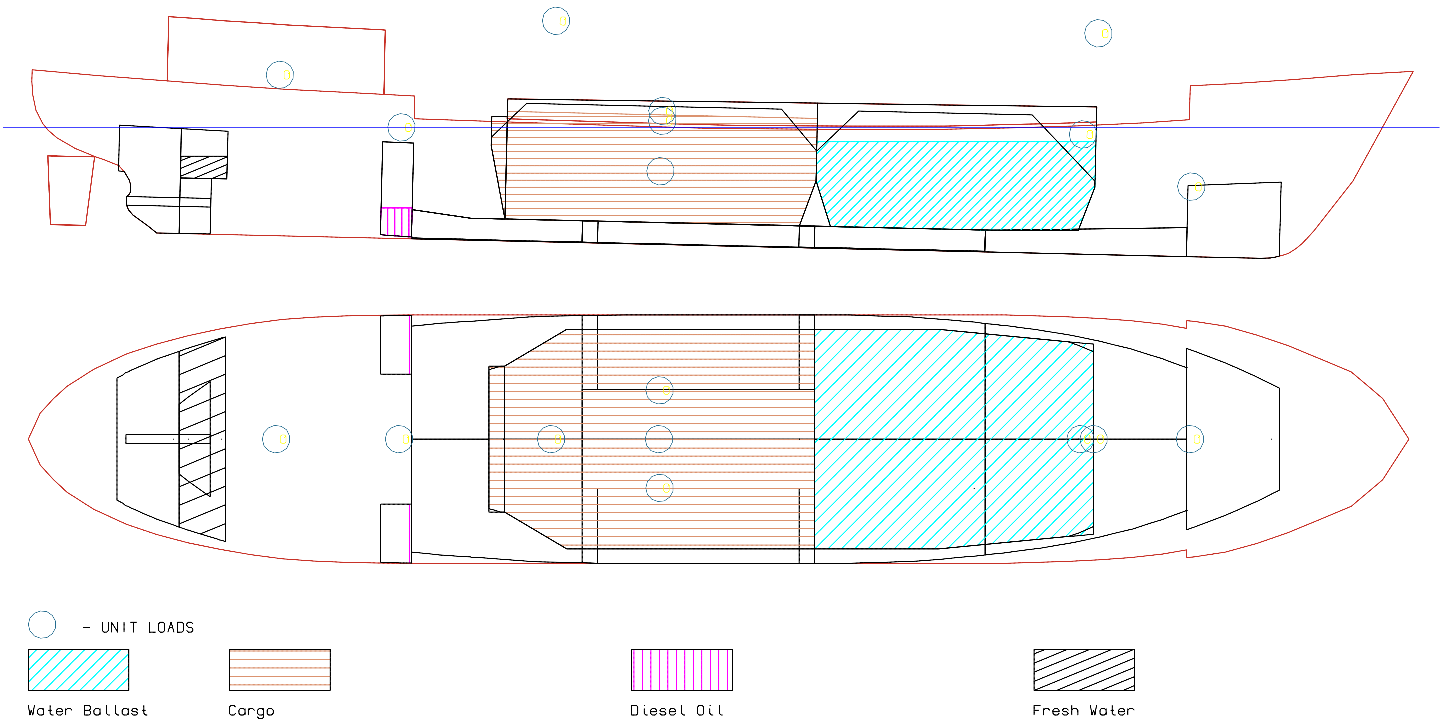
KG (incl. FSC) .... :	3.120	m
Free Surface Correction:	0.230	m
GM (GZ derived) ...... :	0.322	m



Water Density = 1.025 t/m3

Please note !
-Floating data are based on iterations incorporating calculation of exact list (heel giving zero righting lever).
-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the equilibrium calculation.

Loading Condition no. : 24
Condition Id. text : Som 23 med "tank" over forsk. sand



WEIGHT LOADS

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
1	Lasterom Forut	269.981	75.4	1.5119	25.18	34.72	29.832	0.000	2.320	
2	Lasterom Akter	407.959	87.5	1.7501	14.05	25.18	19.856	0.000	2.505	
3	Mannskap, Proviant og Stores									
-	Mannskap, Proviant	0.600					6.770	0.000	5.500	
-	Stores	0.500					34.270	0.000	4.100	
		1.100					19.270	0.000	4.864	
4	Forråd Forliskondisjon									
-	Brennolje Ving S	0.890	20.0	0.8300	10.34	11.40	10.899	2.853	0.661	0.28 ¤
-	Brennolje Ving P	0.890	20.0	0.8300	10.34	11.40	10.897	-2.819	0.660	0.28 ¤
-	Dagtank spt. 21-22	0.720					10.970	0.000	3.800	
-	Ferskvann	5.499	41.0	1.0000	3.45	5.04	4.307	0.223	2.321	22.87 ¤
-	Smøreolje	0.150					38.020	0.000	2.400	
		8.150					6.956	0.154	2.090	
5	Lasterom Forut	76.523	74.7	1.0250	25.18	34.72	29.883	0.041	2.307	136.90 ¤
6	19,2% vann i sand	78.310					19.856	0.000	2.506	
7	SHT forskyvning av sand k 12									
-	Sand ned babord	-14.100					19.880	-1.670	4.227	

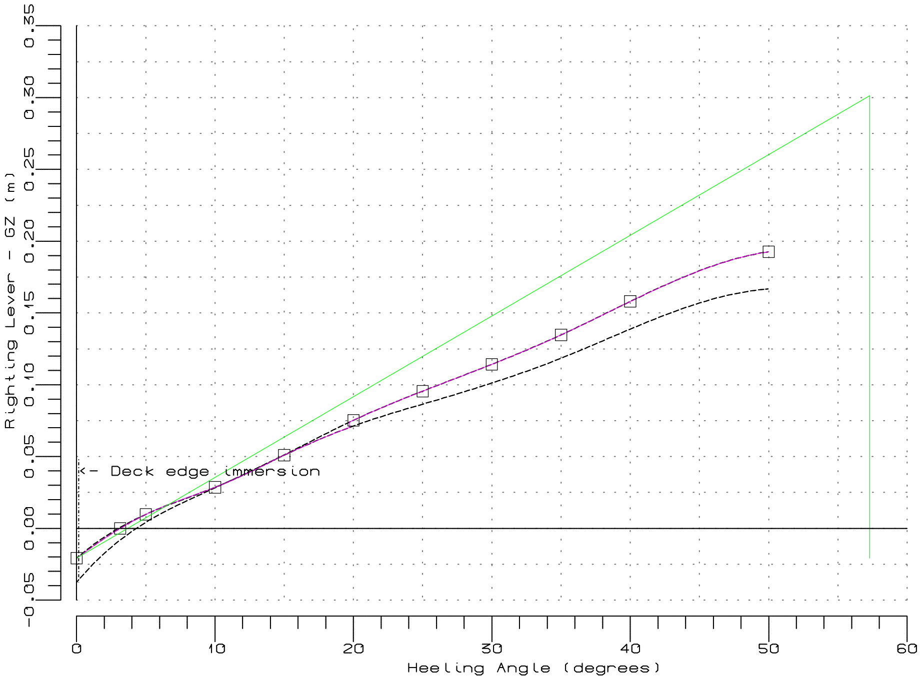
.... to be continued on next page

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
-	Sand opp styrbord	14.100					19.880	1.670	4.567	
		0.000					0.000	0.000	0.000	
8	SHT gr.mask. lcg korr.									
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565	
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	
9	Over sand forskjøvet	28.739	84.1	1.0250	14.58	25.18	20.529	-0.987	4.294	113.18 ¤
	DEAD WEIGHT	870.762					23.092	0.027	2.494	
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	1190.401					22.793	0.019	2.887	

¤) The centre of the liquid in these tanks are allowed to shift with heel. The effect from this is incorporated in the calculated GZ-values. The moment of inertia from these tanks are not used to calculate a constant Free Surface Moment applied to artificially raise the VCG applied in the calculations of GZ-values.

Loading Condition no. : 24
Condition Id. text : Som 23 med "tank" over forsk. sand

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
0.000	-0.021	-0.0006
3.150	0.000	0.0000
5.000	0.010	0.0002
10.000	0.029	0.0019
15.000	0.051	0.0053
20.000	0.075	0.0107
25.000	0.096	0.0182
30.000	0.114	0.0273
35.000	0.135	0.0382
40.000	0.158	0.0509
50.000	0.193	0.0820

Deck immersion : 0.156 °
Maximum GZ at : 50.000 °
Equilibrium at : 3.150 °
Area, 0 - 30 : 0.0279 m*rad
Area, 0 - 40 : 0.0515 m*rad
Area,30 - 40 : 0.0236 m*rad
Area, 0 - maxGZ: 0.0825 m*rad
GM : 0.322 m

Heel to starboard side
Applied VCG : 2.891 m
TCG : 0.020 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Concl-usion
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.193	NOT OK
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	50.000	OK
GMMin	Minimum GM		: 0.15 m	0.322	OK
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.027	NOT OK
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.051	NOT OK
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.024	NOT OK

ß : flooding angle
ð : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : NOT OK

Please note !

The calculations of KGmax are based on upright vessel (TCG=0.0 m). If the actual calculations are based on TCG <> 0.0, the stability conclusion may not correspond with the presented stability margin. The conclusion will anyway be correct as it reflects the actual loading condition.

The calculations of KGmax includes the use of flood openings of type "local flooding". This may cause one or more steps in the KY and GZ curves.
Control of stability for the "GZMi2", "GZPos" and "GZAng" criteria are not influenced by "local flooding" effects.

Please note !

-The calculation of GM is made by finding the tangency line of the GZ-curve for upright vessel (zero heel).
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the calculation of GZ-values. The moment of inertia from these tanks are not contributing to the constant "Free Surface Moment" applied to artificially raise the VCG applied in the calculation of GZ-values

FREE SURFACE EFFECTS ON GZ-VALUES

Angle of heel (degrees)	GZ-values with corr. (m)	GZ-values without corr. (m)
0.000	-0.021	-0.020
5.000	0.010	0.023
10.000	0.029	0.053
15.000	0.051	0.080
20.000	0.075	0.108
25.000	0.096	0.131
30.000	0.114	0.152
35.000	0.135	0.172
40.000	0.158	0.194
50.000	0.193	0.225

The corrected GZ-values are calculated according to the movement of the liquid centers of the compartments listed below.

MOVEMENT OF C.O.G. FOR THE SHIP TOTAL

Movement of center of gravity compared to zero heel and initial trim.

Angle of heel (degrees)	Transversal movement (m)	Vertical movement (m)
0.000	0.001	-0.008
5.000	0.016	-0.025
10.000	0.032	-0.036
15.000	0.041	-0.036
20.000	0.048	-0.033
25.000	0.055	-0.031
30.000	0.060	-0.028
35.000	0.064	-0.025
40.000	0.068	-0.023
50.000	0.073	-0.017

Compartment no. 13 Id. text : Brennolje Ving S

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.898	2.836	0.660
5.000	0.890	0.830	10.899	2.864	0.661
10.000	0.890	0.830	10.901	2.895	0.665
15.000	0.890	0.830	10.903	2.929	0.673
20.000	0.890	0.830	10.904	2.968	0.685
25.000	0.890	0.830	10.906	3.012	0.704
30.000	0.890	0.830	10.909	3.064	0.731
35.000	0.890	0.830	10.911	3.125	0.770
40.000	0.890	0.830	10.914	3.198	0.827
50.000	0.890	0.830	10.920	3.393	1.024
Equilibrium:					
3.150	0.890	0.830	10.899	2.853	0.661

Vertical dist. betw. sea and comp. level at equilibrium : 2.907m

Compartment no. 14 Id. text : Brennolje Ving P

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.898	-2.836	0.660
5.000	0.890	0.830	10.896	-2.810	0.661
10.000	0.890	0.830	10.895	-2.785	0.664
15.000	0.890	0.830	10.894	-2.763	0.669
20.000	0.890	0.830	10.893	-2.741	0.676
25.000	0.890	0.830	10.892	-2.719	0.685
30.000	0.890	0.830	10.891	-2.698	0.696
35.000	0.890	0.830	10.891	-2.677	0.709
40.000	0.890	0.830	10.890	-2.655	0.726
50.000	0.890	0.830	10.890	-2.611	0.771
Equilibrium:					
3.150	0.890	0.830	10.897	-2.819	0.660

Vertical dist. betw. sea and comp. level at equilibrium : 2.577m

Compartment no. 15 Id. text : Ferskvann

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	5.499	1.000	4.307	0.000	2.315
5.000	5.499	1.000	4.306	0.353	2.330
10.000	5.499	1.000	4.305	0.693	2.375
15.000	5.499	1.000	4.303	1.016	2.446
20.000	5.499	1.000	4.296	1.253	2.520
25.000	5.499	1.000	4.294	1.387	2.575
30.000	5.499	1.000	4.292	1.464	2.614
35.000	5.499	1.000	4.292	1.510	2.644
40.000	5.499	1.000	4.291	1.541	2.667
50.000	5.499	1.000	4.291	1.577	2.702
Equilibrium:					
3.150	5.499	1.000	4.307	0.223	2.321

Vertical dist. betw. sea and comp. level at equilibrium : 0.969m

Compartment no. 16 Id. text : Lasterom Forut

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	76.524	1.025	29.881	0.000	2.306
5.000	76.529	1.025	29.885	0.066	2.309
10.000	76.528	1.025	29.891	0.144	2.320
15.000	76.523	1.025	29.901	0.236	2.340
20.000	76.522	1.025	29.911	0.329	2.370
25.000	76.523	1.025	29.920	0.423	2.409
30.000	76.524	1.025	29.928	0.497	2.448
35.000	76.530	1.025	29.936	0.555	2.485
40.000	76.523	1.025	29.946	0.602	2.521
50.000	76.524	1.025	29.970	0.674	2.594
Equilibrium:					
3.150	76.524	1.025	29.883	0.041	2.307

Vertical dist. betw. sea and comp. level at equilibrium : 0.483m

Compartment no. 22 Id. text : Over sand forskjøvet

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	23.706	1.025	20.323	-0.938	4.397
5.000	11.355	1.025	20.765	-1.036	4.229
10.000	0.977	1.025	23.592	-1.073	4.091
15.000	0.000	1.025	24.859	2.454	4.773
20.000	0.000	1.025	0.000	0.000	0.000
25.000	0.000	1.025	0.000	0.000	0.000
30.000	0.000	1.025	0.000	0.000	0.000
35.000	0.000	1.025	0.000	0.000	0.000
40.000	0.000	1.025	0.000	0.000	0.000
50.000	0.000	1.025	0.000	0.000	0.000
Equilibrium:					
3.150	15.948	1.025	20.529	-0.987	4.294

Vertical dist. betw. sea and comp. level at equilibrium : -0.557m

Flood Opening Results

Loading Condition no. : 24 ,Som 23 med "tank" over forsk. sand

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Local flood.		14.6	2.5	4.84	19.73	0.83
2	Lukekarm ved #47	Local flood.		25.2	2.5	4.91	15.98	0.65
3	Lukekarm ved # 47	Local flood.		25.2	2.5	4.91	15.98	0.65
4	Forkant luke	Local flood.		34.7	2.5	5.04	13.93	0.56

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Freeboard to Deck

Loading Condition no. : 24 ,Som 23 med "tank" over forsk. sand

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	1.974	1.974
2	-1.300	0.885	5.451	1.890	1.987
3	-0.843	1.388	5.421	1.822	1.974
4	-0.385	1.811	5.391	1.758	1.957
5	0.530	2.392	5.331	1.645	1.908
6	1.625	2.901	5.273	1.534	1.852
7	1.780	2.953	5.265	1.519	1.843
8	2.680	3.256	5.217	1.434	1.792
9	3.755	3.541	5.161	1.337	1.727
10	4.830	3.767	5.105	1.244	1.658
11	5.905	3.955	5.058	1.162	1.597
12	6.980	4.091	5.011	1.083	1.532
13	8.056	4.170	4.983	1.026	1.484
14	9.131	4.215	4.955	0.970	1.433
15	10.206	4.240	4.921	0.910	1.376
16	11.281	4.250	4.888	0.851	1.318
17	11.399	4.250	4.884	0.845	1.312
18	11.400	4.250	4.110	0.072	0.539
19	12.356	4.250	4.098	0.038	0.505
20	13.430	4.250	4.084	0.000	0.467
21	15.580	4.250	4.059	-0.076	0.391
22	17.730	4.250	4.037	-0.147	0.320
23	19.880	4.250	4.024	-0.209	0.258
24	22.030	4.250	4.023	-0.261	0.206
25	24.180	4.250	4.053	-0.280	0.187
26	26.330	4.250	4.084	-0.299	0.168
27	28.480	4.250	4.135	-0.298	0.169
28	29.555	4.250	4.166	-0.292	0.175
29	30.630	4.250	4.215	-0.268	0.199
30	31.705	4.246	4.263	-0.244	0.222
31	32.780	4.215	4.317	-0.214	0.249
32	33.855	4.182	4.373	-0.182	0.278
33	34.930	4.130	4.442	-0.134	0.320
34	36.006	4.054	4.518	-0.079	0.367
35	37.081	3.933	4.613	-0.003	0.429
36	37.900	3.789	4.725	0.099	0.515
37	37.901	4.051	5.851	1.208	1.653
38	38.156	4.031	5.870	1.222	1.664
39	39.230	3.864	5.948	1.284	1.709
40	40.305	3.562	6.041	1.369	1.760
41	41.380	3.195	6.134	1.457	1.808
42	42.455	2.752	6.247	1.568	1.871
43	43.530	2.300	6.359	1.681	1.933
44	44.605	1.386	6.444	1.791	1.943
45	45.500	0.000	6.515	1.917	1.917

Freeboard is vertical distance from deck point to sea at equilibrium.

Loading Condition no. : 25

Som 22 med "tanker" over forsk. sand og grus

FLOATING CONDITION DATA

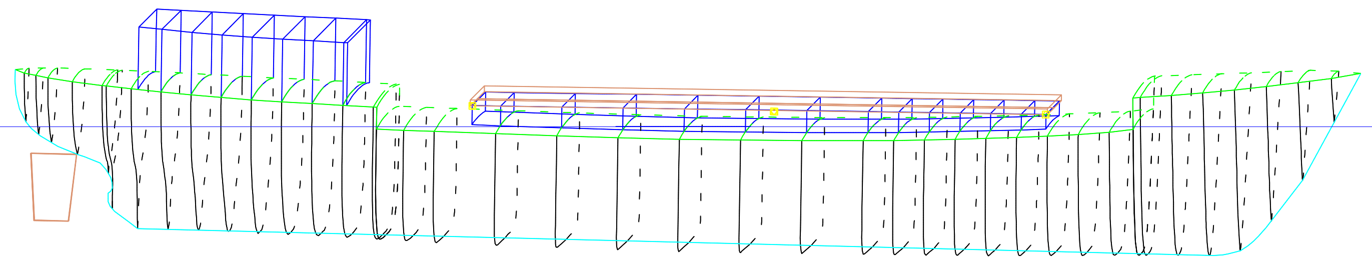
Mean Draught (moulded) :	4.040	m
Trim over Lpp (aft +) :	-1.082	m
List (starboard +) ... :	5.413	°
Draught, AP (moulded) :	3.499	m
Draught, LCF (moulded) :	4.026	m
Draught, FP (moulded) :	4.580	m
Displacement .... :	1176.561	MT
LCB (rel. AP) .... :	22.883	m
VCB (rel. BL) .... :	2.151	m
LCF (rel. AP) .... :	21.204	m
TPC - Immersion ...... :	2.970	MT/cm
Trim Moment .... :	10.091	MT*m/cm

WEIGHT SUMMARY

Cargo :	754.5	MT
Miscellaneous Liquid Loads :	39.4	MT
Miscellaneous Mass Loads :	78.3	MT
Mannskap, Proviant og Stores :	1.1	MT
Forråd Forliskondisjon :	8.1	MT
Total DEADWEIGHT :	881.4	MT

STABILITY DATA/CONTROL

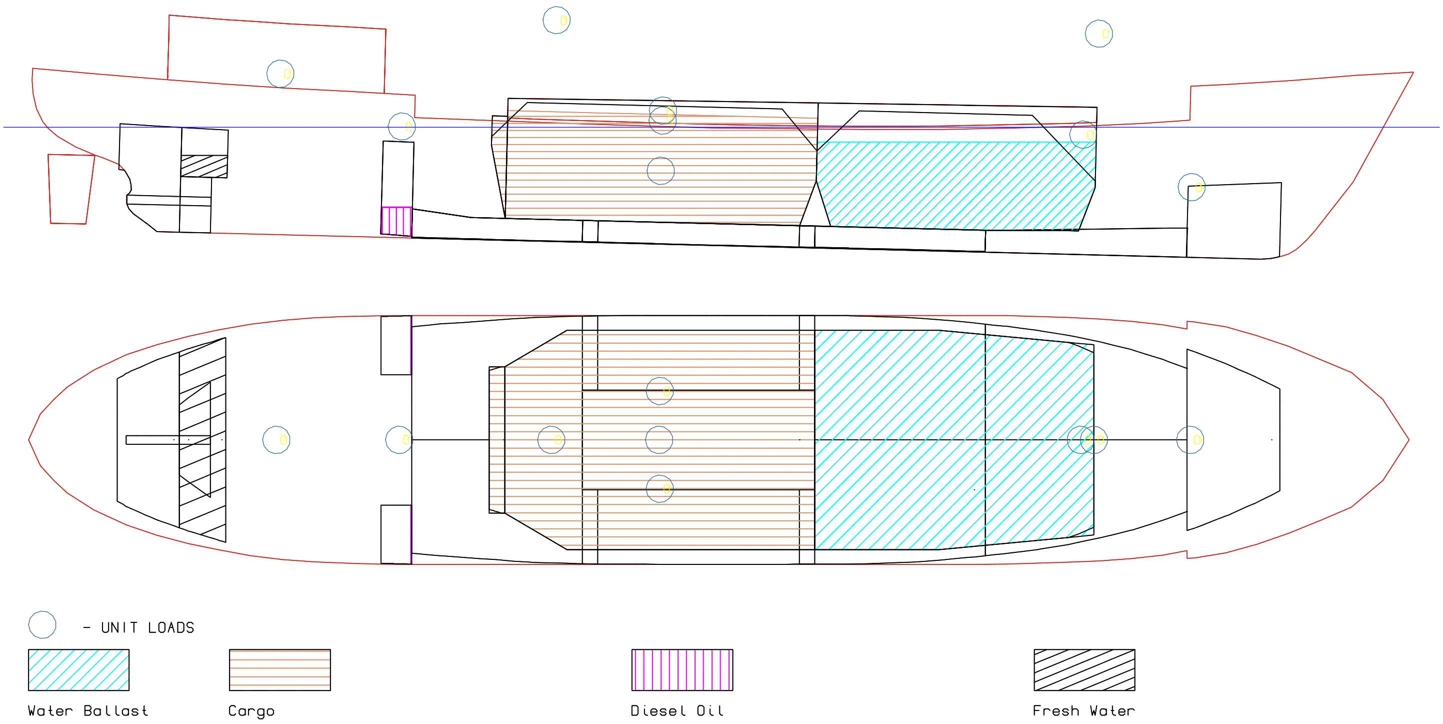
KG (incl. FSC) .... :	3.131	m
Free Surface Correction:	0.228	m
GM (GZ derived) ...... :	0.174	m



Water Density = 1.025 t/m3

Please note !
-Floating data are based on iterations incorporating calculation of exact list (heel giving zero righting lever).
-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the equilibrium calculation.

Loading Condition no. : 25
Condition Id. text : Som 22 med "tanker" over forsk. sand og grus



WEIGHT LOADS

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
1	Lasterom Forut	269.981	75.4	1.5119	25.18	34.72	29.832	0.000	2.320	
2	Lasterom Akter	407.959	87.5	1.7501	14.05	25.18	19.856	0.000	2.505	
3	Mannskap, Proviant og Stores									
-	Mannskap, Proviant	0.600					6.770	0.000	5.500	
-	Stores	0.500					34.270	0.000	4.100	
		1.100					19.270	0.000	4.864	
4	Forråd Forliskondisjon									
-	Brennolje Ving S	0.890	20.0	0.8300	10.34	11.40	10.900	2.867	0.662	0.28 ¤
-	Brennolje Ving P	0.890	20.0	0.8300	10.34	11.40	10.896	-2.808	0.661	0.28 ¤
-	Dagtank spt. 21-22	0.720					10.970	0.000	3.800	
-	Ferskvann	5.499	41.0	1.0000	3.45	5.04	4.307	0.381	2.333	22.87 ¤
-	Smøreolje	0.150					38.020	0.000	2.400	
		8.150					6.956	0.264	2.098	
5	Lasterom Forut	76.523	74.7	1.0250	25.18	34.72	29.888	0.072	2.310	136.90 ¤
6	19,2% vann i sand	78.310					19.856	0.000	2.506	
7	SHT forskyvning av sand k 12									
-	Sand ned babord	-14.100					19.880	-1.670	4.227	

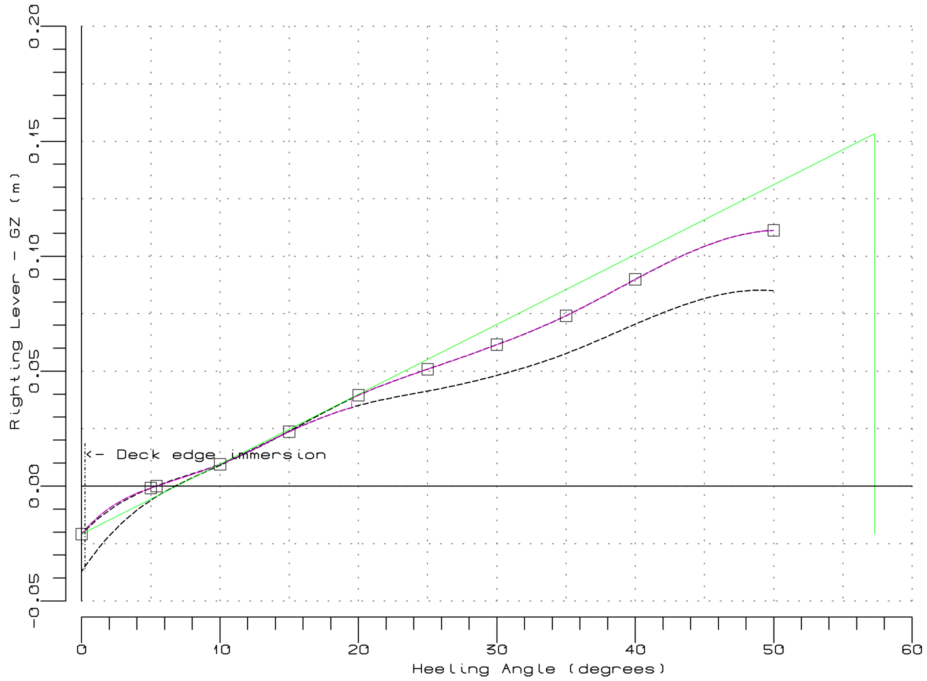
.... to be continued on next page

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
-	Sand opp styrbord	14.100					19.880	1.670	4.567	
		0.000					0.000	0.000	0.000	
8	SHT gr.mask. lcg korr.									
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565	
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	
9	Over sand forskjøvet	34.169	100.0	1.0250	14.58	25.18	20.920	-1.090	4.202	
10	Over grus	5.247	8.8	1.0250	25.18	34.72	30.049	0.000	3.831	113.25
	DEAD WEIGHT	881.439					23.133	0.020	2.510	113.25
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	1201.078					22.826	0.015	2.895	113.25

¤) The centre of the liquid in these tanks are allowed to shift with heel. The effect from this is incorporated in the calculated GZ-values. The moment of inertia from these tanks are not used to calculate a constant Free Surface Moment applied to artificially raise the VCG applied in the calculations of GZ-values.

Loading Condition no. : 25
Condition Id. text : Som 22 med "tanker" over forsk. sand og grus

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
0.000	-0.021	-0.0008
5.000	-0.001	0.0000
5.413	0.000	0.0000
10.000	0.009	0.0004
15.000	0.024	0.0018
20.000	0.040	0.0044
25.000	0.051	0.0084
30.000	0.061	0.0133
35.000	0.074	0.0192
40.000	0.090	0.0263
50.000	0.111	0.0443

Deck immersion : 0.234 °
Maximum GZ at : 50.000 °
Equilibrium at : 5.413 °
Area, 0 - 30 : 0.0141 m*rad
Area, 0 - 40 : 0.0271 m*rad
Area,30 - 40 : 0.0130 m*rad
Area, 0 - maxGZ: 0.0451 m*rad
GM : 0.174 m

Heel to starboard side
Applied VCG : 2.998 m
TCG : 0.020 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Concl-usion
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.111	NOT OK
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	50.000	OK
GMMin	Minimum GM		: 0.15 m	0.174	OK
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.013	NOT OK
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.026	NOT OK
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.013	NOT OK

ß : flooding angle
ð : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : NOT OK

Please note !

The calculations of KGmax are based on upright vessel (TCG=0.0 m). If the actual calculations are based on TCG <> 0.0, the stability conclusion may not correspond with the presented stability margin. The conclusion will anyway be correct as it reflects the actual loading condition.

The calculations of KGmax includes the use of flood openings of type "local flooding". This may cause one or more steps in the KY and GZ curves.
Control of stability for the "GZMi2", "GZPos" and "GZAng" criteria are not influenced by "local flooding" effects.

Please note !

-The calculation of GM is made by finding the tangency line of the GZ-curve for upright vessel (zero heel).
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the calculation of GZ-values. The moment of inertia from these tanks are not contributing to the constant "Free Surface Moment" applied to artificially raise the VCG applied in the calculation of GZ-values

FREE SURFACE EFFECTS ON GZ-VALUES

Angle of heel (degrees)	GZ-values with corr. (m)	GZ-values without corr. (m)
0.000	-0.021	-0.020
5.000	-0.001	0.012
10.000	0.009	0.033
15.000	0.024	0.051
20.000	0.040	0.070
25.000	0.051	0.084
30.000	0.061	0.096
35.000	0.074	0.108
40.000	0.090	0.122
50.000	0.111	0.139

The corrected GZ-values are calculated according to the movement of the liquid centers of the compartments listed below.

MOVEMENT OF C.O.G. FOR THE SHIP TOTAL

Movement of center of gravity compared to zero heel and initial trim.

Angle of heel (degrees)	Transversal movement (m)	Vertical movement (m)
0.000	0.001	-0.017
5.000	0.016	-0.033
10.000	0.032	-0.043
15.000	0.041	-0.042
20.000	0.048	-0.039
25.000	0.055	-0.037
30.000	0.060	-0.034
35.000	0.064	-0.031
40.000	0.067	-0.029
50.000	0.072	-0.023

Compartment no. 13 Id. text : Brennolje Ving S

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.898	2.836	0.660
5.000	0.890	0.830	10.899	2.864	0.661
10.000	0.890	0.830	10.901	2.895	0.665
15.000	0.890	0.830	10.903	2.929	0.673
20.000	0.890	0.830	10.905	2.968	0.686
25.000	0.890	0.830	10.907	3.012	0.704
30.000	0.890	0.830	10.909	3.064	0.731
35.000	0.890	0.830	10.912	3.125	0.770
40.000	0.890	0.830	10.915	3.198	0.827
50.000	0.890	0.830	10.920	3.393	1.024
Equilibrium:					
5.413	0.890	0.830	10.900	2.867	0.662

Vertical dist. betw. sea and comp. level at equilibrium : 3.013m

Compartment no. 14 Id. text : Brennolje Ving P

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.898	-2.836	0.660
5.000	0.890	0.830	10.897	-2.810	0.661
10.000	0.890	0.830	10.895	-2.785	0.664
15.000	0.890	0.830	10.894	-2.763	0.669
20.000	0.890	0.830	10.893	-2.741	0.676
25.000	0.890	0.830	10.892	-2.719	0.685
30.000	0.890	0.830	10.892	-2.698	0.696
35.000	0.890	0.830	10.891	-2.677	0.709
40.000	0.890	0.830	10.890	-2.655	0.726
50.000	0.890	0.830	10.890	-2.611	0.771
Equilibrium:					
5.413	0.890	0.830	10.896	-2.808	0.661

Vertical dist. betw. sea and comp. level at equilibrium : 2.445m

Compartment no. 15 Id. text : Ferskvann

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	5.499	1.000	4.307	0.000	2.315
5.000	5.499	1.000	4.307	0.353	2.330
10.000	5.499	1.000	4.306	0.693	2.375
15.000	5.499	1.000	4.303	1.016	2.446
20.000	5.499	1.000	4.296	1.253	2.520
25.000	5.499	1.000	4.294	1.387	2.575
30.000	5.499	1.000	4.293	1.464	2.614
35.000	5.499	1.000	4.292	1.510	2.644
40.000	5.499	1.000	4.292	1.541	2.667
50.000	5.499	1.000	4.291	1.577	2.702
Equilibrium:					
5.413	5.499	1.000	4.307	0.381	2.333

Vertical dist. betw. sea and comp. level at equilibrium : 0.957m

Compartment no. 16 Id. text : Lasterom Forut

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	76.524	1.025	29.883	0.000	2.306
5.000	76.529	1.025	29.887	0.066	2.309
10.000	76.528	1.025	29.894	0.144	2.320
15.000	76.523	1.025	29.903	0.236	2.340
20.000	76.522	1.025	29.913	0.330	2.370
25.000	76.523	1.025	29.924	0.423	2.409
30.000	76.524	1.025	29.931	0.497	2.448
35.000	76.529	1.025	29.939	0.555	2.485
40.000	76.524	1.025	29.949	0.602	2.521
50.000	76.524	1.025	29.973	0.674	2.595
Equilibrium:					
5.413	76.529	1.025	29.888	0.072	2.310

Vertical dist. betw. sea and comp. level at equilibrium : 0.499m

Compartment no. 22 Id. text : Over sand forskjøvet

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	22.930	1.025	20.352	-0.962	4.387
5.000	10.648	1.025	20.836	-1.075	4.217
10.000	0.767	1.025	23.762	-1.160	4.071
15.000	0.000	1.025	0.000	0.000	0.000
20.000	0.000	1.025	0.000	0.000	0.000
25.000	0.000	1.025	0.000	0.000	0.000
30.000	0.000	1.025	0.000	0.000	0.000
35.000	0.000	1.025	0.000	0.000	0.000
40.000	0.000	1.025	0.000	0.000	0.000
50.000	0.000	1.025	0.000	0.000	0.000
Equilibrium:					
5.413	9.646	1.025	20.920	-1.090	4.202

Vertical dist. betw. sea and comp. level at equilibrium : -0.420m

Flood Opening Results

Loading Condition no. : 25 ,Som 22 med "tanker" over forsk. sand og grus

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Local flood.		14.6	2.5	4.84	19.51	0.73
2	Lukekarm ved #47	Local flood.		25.2	2.5	4.91	15.59	0.53
3	Lukekarm ved # 47	Local flood.		25.2	2.5	4.91	15.59	0.53
4	Forkant luke	Local flood.		34.7	2.5	5.04	13.36	0.42

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Freeboard to Deck

Loading Condition no. : 25 ,Som 22 med "tanker" over forsk. sand og grus

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	1.996	1.996
2	-1.300	0.885	5.451	1.876	2.043
3	-0.843	1.388	5.421	1.788	2.049
4	-0.385	1.811	5.391	1.706	2.048
5	0.530	2.392	5.331	1.569	2.020
6	1.625	2.901	5.273	1.436	1.983
7	1.780	2.953	5.265	1.419	1.976
8	2.680	3.256	5.217	1.321	1.935
9	3.755	3.541	5.161	1.212	1.879
10	4.830	3.767	5.105	1.108	1.818
11	5.905	3.955	5.058	1.017	1.763
12	6.980	4.091	5.011	0.930	1.702
13	8.056	4.170	4.983	0.868	1.655
14	9.131	4.215	4.955	0.809	1.604
15	10.206	4.240	4.921	0.747	1.547
16	11.281	4.250	4.888	0.686	1.487
17	11.399	4.250	4.884	0.679	1.481
18	11.400	4.250	4.110	-0.091	0.710
19	12.356	4.250	4.098	-0.127	0.675
20	13.430	4.250	4.084	-0.167	0.635
21	15.580	4.250	4.059	-0.246	0.556
22	17.730	4.250	4.037	-0.321	0.481
23	19.880	4.250	4.024	-0.387	0.415
24	22.030	4.250	4.023	-0.442	0.360
25	24.180	4.250	4.053	-0.465	0.337
26	26.330	4.250	4.084	-0.488	0.313
27	28.480	4.250	4.135	-0.490	0.311
28	29.555	4.250	4.166	-0.486	0.315
29	30.630	4.250	4.215	-0.465	0.337
30	31.705	4.246	4.263	-0.442	0.358
31	32.780	4.215	4.317	-0.413	0.382
32	33.855	4.182	4.373	-0.381	0.408
33	34.930	4.130	4.442	-0.334	0.445
34	36.006	4.054	4.518	-0.277	0.487
35	37.081	3.933	4.613	-0.199	0.543
36	37.900	3.789	4.725	-0.094	0.621
37	37.901	4.051	5.851	1.002	1.766
38	38.156	4.031	5.870	1.016	1.776
39	39.230	3.864	5.948	1.083	1.812
40	40.305	3.562	6.041	1.177	1.849
41	41.380	3.195	6.134	1.278	1.881
42	42.455	2.752	6.247	1.405	1.924
43	43.530	2.300	6.359	1.533	1.967
44	44.605	1.386	6.444	1.677	1.938
45	45.500	0.000	6.515	1.856	1.856

Freeboard is vertical distance from deck point to sea at equilibrium.

Loading Condition no. : 26

Som 21 med "tanker" over forsk. sand og grus

FLOATING CONDITION DATA

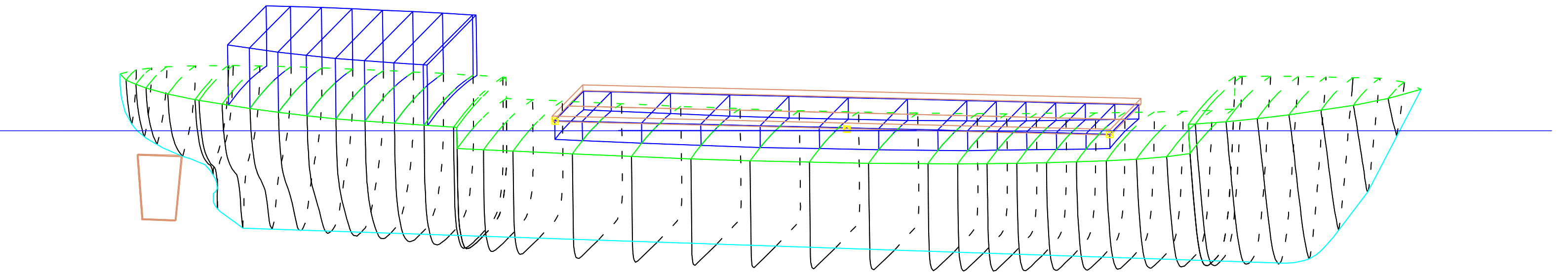
Mean Draught (moulded) :	4.106	m
Trim over Lpp (aft +) :	-1.443	m
List (starboard +) ... :	12.131	°
Draught, AP (moulded) :	3.385	m
Draught, LCF (moulded) :	4.086	m
Draught, FP (moulded) :	4.828	m
Displacement .... :	1198.609	MT
LCB (rel. AP) .... :	23.103	m
VCB (rel. BL) .... :	2.135	m
LCF (rel. AP) .... :	21.135	m
TPC - Immersion ...... :	2.910	MT/cm
Trim Moment .... :	9.383	MT*m/cm

WEIGHT SUMMARY

Cargo :	754.5	MT
Miscellaneous Liquid Loads :	93.8	MT
Miscellaneous Mass Loads :	78.3	MT
Mannskap, Proviant og Stores :	1.1	MT
Forråd Forliskondisjon :	8.1	MT
Total DEADWEIGHT :	935.8	MT

STABILITY DATA/CONTROL

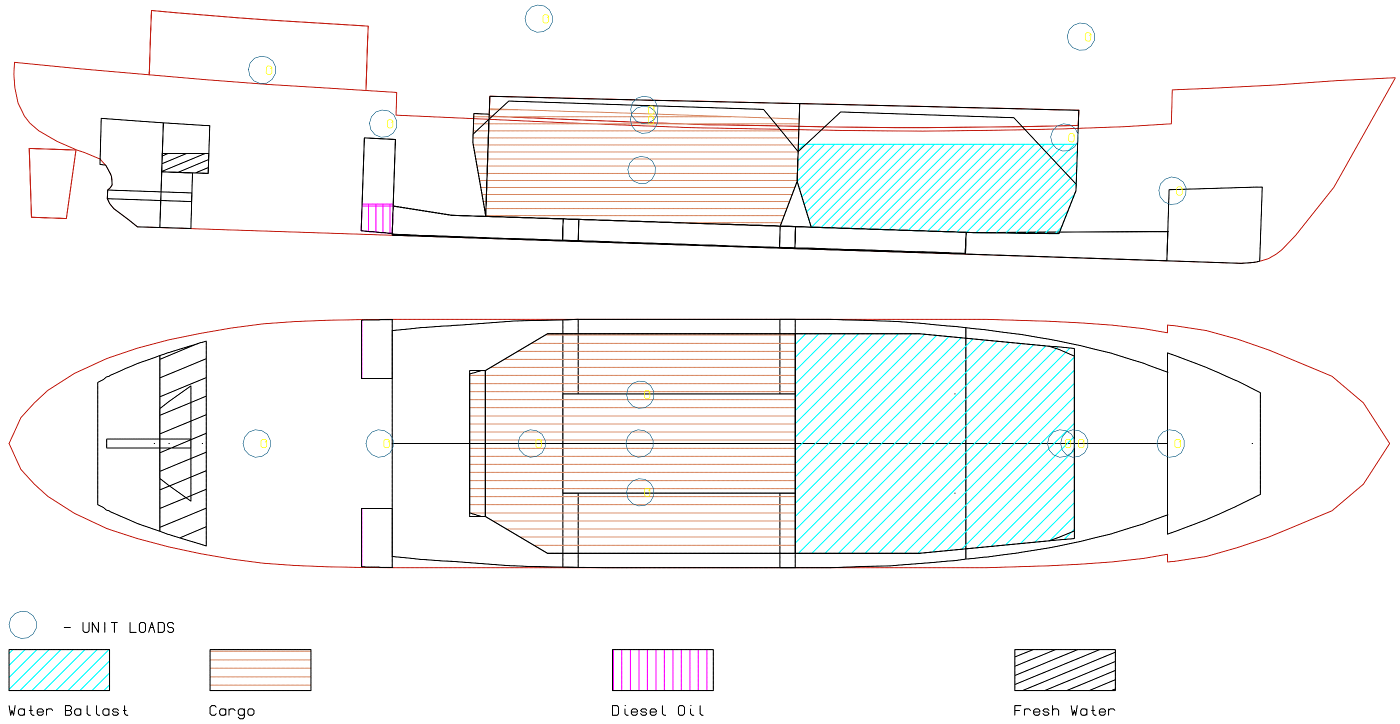
KG (incl. FSC) .... :	3.098	m
Free Surface Correction:	0.128	m
GM (GZ derived) ...... :	-0.045	m



Water Density = 1.025 t/m3

Please note !
-Floating data are based on iterations incorporating calculation of exact list (heel giving zero righting lever).
-GM is calculated based on metacentric height (KMT) for upright vessel (zero heel)
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the equilibrium calculation.

Loading Condition no. : 26
Condition Id. text : Som 21 med "tanker" over forsk. sand og grus



WEIGHT LOADS

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)	
1	Lasterom Forut	269.981	75.4	1.5119	25.18	34.72	29.832	0.000	2.320		
2	Lasterom Akter	407.959	87.5	1.7501	14.05	25.18	19.856	0.000	2.505		
3	Mannskap, Proviant og Stores										
-	Mannskap, Proviant	0.600					6.770	0.000	5.500		
-	Stores	0.500					34.270	0.000	4.100		
		1.100					19.270	0.000	4.864		
4	Forråd Forliskondisjon										
-	Brennolje Ving S	0.890	20.0	0.8300	10.34	11.40	10.903	2.909	0.668	0.28	¤
-	Brennolje Ving P	0.890	20.0	0.8300	10.34	11.40	10.896	-2.776	0.666	0.28	¤
-	Dagtank spt. 21-22	0.720					10.970	0.000	3.800		
-	Ferskvann	5.499	41.0	1.0000	3.45	5.04	4.308	0.834	2.402	22.87	¤
-	Smøreolje	0.150					38.020	0.000	2.400		
		8.150					6.957	0.578	2.147		
5	Lasterom Forut	76.523	74.7	1.0250	25.18	34.72	29.915	0.184	2.328	136.90	¤
6	19,2% vann i sand	78.310					19.856	0.000	2.506		
7	SHT forskyvning av sand k 12										
-	Sand ned babord	-14.100					19.880	-1.670	4.227		

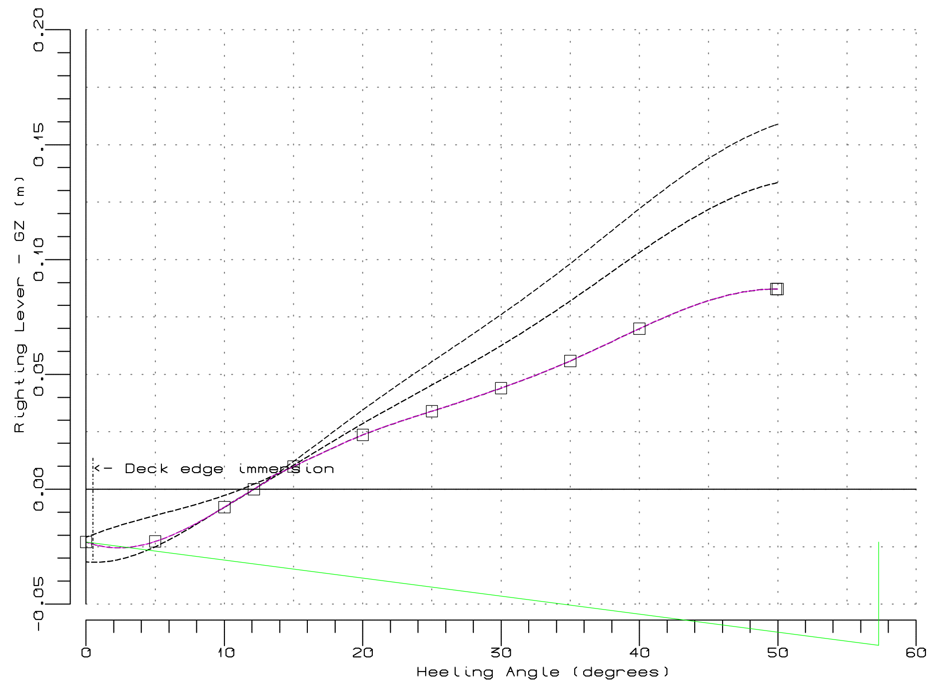
.... to be continued on next page

Part no.	Id.text	Weight (MT)	Load (%)	Density (MT/m3)	Distribution Aft (m)	Distribution Fore (m)	LCG (m)	TCG (m)	VCG (m)	FSCT Moment (MT*m)
-	Sand opp styrbord	14.100					19.880	1.670	4.567	
		0.000					0.000	0.000	0.000	
8	SHT gr.mask. lcg korr.									
-	Gr.mask. kr.prøve	-30.000					34.720	0.000	7.565	
-	Gr.mask. forlis	30.000					16.170	0.000	7.565	
		0.000					0.000	0.000	0.000	
9	Over grus	59.627	100.0	1.0250	25.18	34.72	30.302	0.577	4.218	
10	Over sand forskjøvet	34.169	100.0	1.0250	14.58	25.18	24.612	1.020	4.497	
	DEAD WEIGHT	935.818					23.688	0.144	2.624	
	LIGHT WEIGHT, Korr KrPr	319.639					21.979	0.000	3.957	
	TOTAL WEIGHT	1255.457					23.253	0.108	2.963	

¤) The centre of the liquid in these tanks are allowed to shift with heel. The effect from this is incorporated in the calculated GZ-values. The moment of inertia from these tanks are not used to calculate a constant Free Surface Moment applied to artificially raise the VCG applied in the calculations of GZ-values.

Loading Condition no. : 26
Condition Id. text : Som 21 med "tanker" over forsk. sand og grus

INTACT STABILITY DATA (GZ-curve, Areas, Particulars & Criteria Control)



Angle (degr.)	GZ (m)	Area (m*rad)
0.000	-0.023	-0.0037
5.000	-0.023	-0.0015
10.000	-0.008	-0.0001
12.131	0.000	0.0000
15.000	0.010	0.0003
20.000	0.024	0.0017
25.000	0.034	0.0043
30.000	0.044	0.0077
35.000	0.056	0.0120
40.000	0.070	0.0175
49.887	0.087	0.0314
50.000	0.087	0.0316

Deck immersion : 0.508 °
Maximum GZ at : 49.887 °
Equilibrium at : 12.131 °
Area, 0 - 30 : 0.0114 m*rad
Area, 0 - 40 : 0.0212 m*rad
Area,30 - 40 : 0.0098 m*rad
Area, 0 - maxGZ: 0.0351 m*rad
GM : -0.045 m

Heel to starboard side
Applied VCG : 2.970 m
TCG : 0.019 m

Table of intact stability criteria

TYPE : IMO A.167 (ES.IV)

Code	Id. text		Req.	Actual value	Concl-usion
GZMi1	GZ at angle greater or equal to 30.0°		: 0.20 m	0.087	NOT OK
GZAng	Angle at which max. GZ occur, ð		: 25.00 °	50.000	OK
GMMin	Minimum GM		: 0.15 m	-0.045	NOT OK
GZAr1	Area, GZ curve (0.0-30.0)°	*)	: 0.055 m·rad	0.008	NOT OK
GZAr2	Area, GZ curve (0.0-min<40.0,ß>)°	*)	: 0.090 m·rad	0.017	NOT OK
GZAr2	Area, GZ curve (30.0-min<40.0,ß>)°	*)	: 0.030 m·rad	0.010	NOT OK

ß : flooding angle
ð : angle for maximum GZ
GZarea : area of righting lever
*) : area will also be limited by angles for equilibrium and 2nd intercept

Intact Stability conclusion ...... : NOT OK

Please note !

The calculation of KGmax are based on upright vessel (TCG=0.0 m). If the actual calculations are based on TCG <> 0.0, the stability conclusion may not correspond with the presented stability margin. The conclusion will anyway be correct as it reflects the actual loading condition.

The calculations of KGmax includes the use of flood openings of type "local flooding". This may cause one or more steps in the KY and GZ curves.
Control of stability for the "GZMi2", "GZPos" and "GZAng" criteria are not influenced by "local flooding" effects.

Please note !

-The calculation of GM is made by finding the tangency line of the GZ-curve for upright vessel (zero heel).
-The centre of the liquid in some or all tanks are allowed to shift with heel. The effect from this is incorporated in the calculation of GZ-values. The moment of inertia from these tanks are not contributing to the constant "Free Surface Moment" applied to artificially raise the VCG applied in the calculation of GZ-values

FREE SURFACE EFFECTS ON GZ-VALUES

Angle of heel (degrees)	GZ-values with corr. (m)	GZ-values without corr. (m)
0.000	-0.023	-0.019
5.000	-0.023	-0.002
10.000	-0.008	0.024
15.000	0.010	0.048
20.000	0.024	0.065
25.000	0.034	0.077
30.000	0.044	0.086
35.000	0.056	0.095
40.000	0.070	0.105
50.000	0.087	0.114

The corrected GZ-values are calculated according to the movement of the liquid centers of the compartments listed below.

MOVEMENT OF C.O.G. FOR THE SHIP TOTAL

Movement of center of gravity compared to zero heel and initial trim.

Angle of heel (degrees)	Transversal movement (m)	Vertical movement (m)
0.000	0.004	-0.027
5.000	0.025	-0.050
10.000	0.046	-0.069
15.000	0.062	-0.075
20.000	0.072	-0.070
25.000	0.079	-0.064
30.000	0.084	-0.059
35.000	0.087	-0.054
40.000	0.089	-0.049
50.000	0.089	-0.038

Compartment no. 13 Id. text : Brennolje Ving S

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.899	2.836	0.660
5.000	0.890	0.830	10.900	2.864	0.661
10.000	0.890	0.830	10.902	2.895	0.666
15.000	0.890	0.830	10.904	2.930	0.673
20.000	0.890	0.830	10.906	2.968	0.686
25.000	0.890	0.830	10.908	3.013	0.704
30.000	0.890	0.830	10.911	3.064	0.731
35.000	0.890	0.830	10.914	3.125	0.770
40.000	0.890	0.830	10.917	3.199	0.827
50.000	0.890	0.830	10.924	3.392	1.024
Equilibrium:					
12.131	0.890	0.830	10.903	2.909	0.668

Vertical dist. betw. sea and comp. level at equilibrium : 3.359m

Compartment no. 14 Id. text : Brennolje Ving P

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	0.890	0.830	10.899	-2.836	0.660
5.000	0.890	0.830	10.897	-2.810	0.661
10.000	0.890	0.830	10.896	-2.786	0.664
15.000	0.890	0.830	10.895	-2.763	0.669
20.000	0.890	0.830	10.894	-2.741	0.676
25.000	0.890	0.830	10.893	-2.719	0.685
30.000	0.890	0.830	10.893	-2.698	0.696
35.000	0.890	0.830	10.892	-2.677	0.709
40.000	0.890	0.830	10.892	-2.656	0.726
50.000	0.890	0.830	10.892	-2.611	0.771
Equilibrium:					
12.131	0.890	0.830	10.896	-2.776	0.666

Vertical dist. betw. sea and comp. level at equilibrium : 2.097m

Compartment no. 15 Id. text : Ferskvann

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	5.499	1.000	4.309	0.000	2.315
5.000	5.499	1.000	4.308	0.353	2.330
10.000	5.499	1.000	4.308	0.693	2.375
15.000	5.499	1.000	4.305	1.015	2.446
20.000	5.499	1.000	4.298	1.252	2.520
25.000	5.499	1.000	4.296	1.387	2.575
30.000	5.499	1.000	4.294	1.463	2.614
35.000	5.499	1.000	4.294	1.510	2.644
40.000	5.499	1.000	4.293	1.541	2.667
50.000	5.499	1.000	4.293	1.576	2.702
Equilibrium:					
12.131	5.499	1.000	4.308	0.834	2.402

Vertical dist. betw. sea and comp. level at equilibrium : 0.973m

Compartment no. 16 Id. text : Lasterom Forut

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	76.524	1.025	29.895	0.000	2.306
5.000	76.529	1.025	29.900	0.067	2.309
10.000	76.528	1.025	29.908	0.145	2.320
15.000	76.523	1.025	29.920	0.237	2.341
20.000	76.522	1.025	29.932	0.330	2.371
25.000	76.523	1.025	29.943	0.422	2.409
30.000	76.524	1.025	29.951	0.497	2.448
35.000	76.526	1.025	29.960	0.555	2.486
40.000	76.524	1.025	29.972	0.601	2.522
50.000	76.524	1.025	30.000	0.673	2.596
Equilibrium:					
12.131	76.522	1.025	29.915	0.184	2.328

Vertical dist. betw. sea and comp. level at equilibrium : 0.648m

Compartment no. 20 Id. text : Over grus

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	59.426	1.025	30.042	0.000	4.386
5.000	52.114	1.025	30.187	0.148	4.319
10.000	41.474	1.025	30.262	0.415	4.241
15.000	34.818	1.025	30.304	0.741	4.232
20.000	36.537	1.025	30.241	0.814	4.279
25.000	38.230	1.025	30.204	0.809	4.307
30.000	39.964	1.025	30.183	0.770	4.326
35.000	41.741	1.025	30.171	0.715	4.339
40.000	43.572	1.025	30.165	0.650	4.349
50.000	47.581	1.025	30.159	0.493	4.364
Equilibrium:					
12.131	36.764	1.025	30.302	0.577	4.218

Vertical dist. betw. sea and comp. level at equilibrium : -0.056m

Compartment no. 22 Id. text : Over sand forskjøvet

Angle of heel (degrees)	Weight in tank (tonnes)	Specific weight (t/m**3)	Gravity coordinates X (m)	Y (m)	Z (m)
0.000	19.259	1.025	20.512	-1.081	4.339
5.000	7.592	1.025	21.238	-1.252	4.160
10.000	0.158	1.025	24.440	-1.663	3.954
15.000	0.000	1.025	0.000	0.000	0.000
20.000	0.000	1.025	0.000	0.000	0.000
25.000	0.000	1.025	0.000	0.000	0.000
30.000	0.000	1.025	0.000	0.000	0.000
35.000	0.000	1.025	0.000	0.000	0.000
40.000	0.000	1.025	0.000	0.000	0.000
50.000	0.000	1.025	0.000	0.000	0.000
Equilibrium:					
12.131	0.185	1.025	24.612	1.020	4.497

Vertical dist. betw. sea and comp. level at equilibrium : 0.000m

Flood Opening Results

Loading Condition no. : 26 ,Som 21 med "tanker" over forsk. sand og grus

No.	Identification text	Type	OvFl Syst	X (m)	Y (m)	Z (m)	Flooding Angle (degr)	Above Sea (m)
1	Akterkant luke	Local flood.		14.6	2.5	4.84	18.44	0.34
2	Lukekarm ved #47	Local flood.		25.2	2.5	4.91	13.36	0.06
3	Lukekarm ved # 47	Local flood.		25.2	2.5	4.91	13.32	0.05
4	Forkant luke	Local flood.		34.7	2.5	5.04	9.02	-0.13

Above Sea is vertical distance from opening to sea at equilibrium.
**) Flooding angle is outside of specified heel range.

Freeboard to Deck

Loading Condition no. : 26 ,Som 21 med "tanker" over forsk. sand og grus

No.	X (m)	Y (m)	Z (m)	Freeboard Starboard (m)	Freeboard Port (m)
1	-1.700	0.000	5.477	2.025	2.025
2	-1.300	0.885	5.451	1.801	2.172
3	-0.843	1.388	5.421	1.651	2.233
4	-0.385	1.811	5.391	1.517	2.278
5	0.530	2.392	5.331	1.306	2.311
6	1.625	2.901	5.273	1.106	2.325
7	1.780	2.953	5.265	1.082	2.323
8	2.680	3.256	5.217	0.942	2.310
9	3.755	3.541	5.161	0.792	2.279
10	4.830	3.767	5.105	0.654	2.237
11	5.905	3.955	5.058	0.533	2.194
12	6.980	4.091	5.011	0.423	2.141
13	8.056	4.170	4.983	0.343	2.095
14	9.131	4.215	4.955	0.271	2.041
15	10.206	4.240	4.921	0.197	1.978
16	11.281	4.250	4.888	0.127	1.912
17	11.399	4.250	4.884	0.119	1.904
18	11.400	4.250	4.110	-0.637	1.148
19	12.356	4.250	4.098	-0.681	1.105
20	13.430	4.250	4.084	-0.730	1.056
21	15.580	4.250	4.059	-0.826	0.959
22	17.730	4.250	4.037	-0.918	0.867
23	19.880	4.250	4.024	-1.002	0.783
24	22.030	4.250	4.023	-1.075	0.711
25	24.180	4.250	4.053	-1.116	0.669
26	26.330	4.250	4.084	-1.158	0.628
27	28.480	4.250	4.135	-1.179	0.606
28	29.555	4.250	4.166	-1.184	0.601
29	30.630	4.250	4.215	-1.172	0.613
30	31.705	4.246	4.263	-1.159	0.624
31	32.780	4.215	4.317	-1.136	0.634
32	33.855	4.182	4.373	-1.111	0.646
33	34.930	4.130	4.442	-1.067	0.668
34	36.006	4.054	4.518	-1.012	0.690
35	37.081	3.933	4.613	-0.931	0.722
36	37.900	3.789	4.725	-0.817	0.774
37	37.901	4.051	5.851	0.227	1.929
38	38.156	4.031	5.870	0.241	1.935
39	39.230	3.864	5.948	0.317	1.941
40	40.305	3.562	6.041	0.436	1.932
41	41.380	3.195	6.134	0.568	1.911
42	42.455	2.752	6.247	0.736	1.892
43	43.530	2.300	6.359	0.905	1.871
44	44.605	1.386	6.444	1.145	1.727
45	45.500	0.000	6.515	1.475	1.475

Freeboard is vertical distance from deck point to sea at equilibrium.

NCC

Prosedyre for dokumenthåndtering av skipslasting

1. FORMÅL

Denne instruks skal sikre korrekt håndtering og utfylling av skipsdokumenter ved lasting av båt, og at disse dokumentene deretter kommer frem til rette mottakere.

2. GYLDIGHET

Denne instruks har gyldighet for all utlasting av bedriftens egne produkter på skip.

3. ANSVAR

Ved lasting av sandprodukter har den av bedriftens ansatte som utfører lastingen ansvar for dokumentene.

Hvis avskiper har utpekt kontrollant til å overvåke kvalitetssortering og lasting, kan ansvaret for denne instruks etter konkret avtale overtas av kontrollanten.

4. BESKRIVELSE

RAPPORT FOR KONTROLL AV SKIP OG LASTEROM

Et eksemplar i utfylt stand, signert av lasteansvarlig fra bedriften og skipets kaptein eller ansvarlig dekksoffiser, bringes til kontoret.

LASTERAPPORT

Dette skal fremgå i rapporten: Skipets navn, lossehavn, vareslag, ankomst lasting påbegynt dato, lasting avsluttet dato avseilt, avlest vekt og korrigert vekt skal framgå i rapporten, lastens fordeling i skipet.

Et eksemplar i utfylt stand, signert av lasteansvarlig og skipets kaptein/ansvarlig offiser, bringes til kontoret.

AVFALLSRAPPORT (disposal of garbage)

Et eksemplar i utfylt stand, signert av skipets kaptein og avdelingsleder bringes til kontoret.

TROSSEMANN

Trossemann skal alltid ha flytevest på når skip skal fortøyes.

Dersom skipet forlanger trossemann, skal eget skjema for dette fylles ut med ankomst/avgang
Et eksemplar i utfylt stand underskrives av ansvarlig offiser og trossemann bringes til kontoret.

BILL OF LOADING

Den lasteansvarliges oppgave er:

Prosedyre for dokumenthåndtering av skipslasting

- Hente dokumentkonvolutten fra skipningstavlen på kontoret.
- Bringe dokumentene ombord og påse at alle fem eksemplarer av B/L blir signert av kapteinen.
- Fylle inn tonnasjen(e).
- Fordele disse slik:

En original og en kopi i konvolutt mrk. "Skipspost" og levere denne til kapteinen.
En kopi til kapteinen.
En original og en kopi til eget kontor.

ANDRE DOKUMENTER

Eventuelle andre dokumenter etter evt. egen instruks. Dette gjelder spesielt lekterlasting, hvor lekteren avleses før og etter lasting. Avleste mål påføres lekterdokumentet (kap. 11).

AVVIKELSER

Ved innsigelser fra skipets kaptein om signering, eller krav om spesiell påtegning på "Bill of Loading", tar lasteansvarlig omgående kontakt med overordnet eller skipets agent.

CE Stat havarikomm or transport

KONTROLLRÅDET
for betongprodukter

NCC

Logg/Båttransport

48012R Logg/Båttransport, AOH 28.04.08

Anløpsnummer: ______________ **Rekv. nummer:** ________________

Båtens navn | Ankommer kai kl (tid/dato)

Lasterom inspisert og funnet i orden | Ja ☐ | Nei ☐

Hvis nei, hvilke bemerkninger

Lasterom godkjent kl (tid/dato)

Signatur ansvarlig (ansatt NCC)

Lasting startet kl (tid/dato) | og avsluttet kl (tid/dato)

Kunde:

Fraksjon	Varenr	Type	Kvantum	Leveres kai

Avgang kl (tid/dato) ________________________ ________________________

Signatur båtfører

Ankomst mottakersted (Navn - sted/kai) | kl (tid/dato)

Lossing startet kl (tid/dato) | og avsluttet kl (tid/dato)

Eventuelle bemerkninger

Blad 1 - hvit:	Gjenpart til mottaker
Blad 2 - gul:	Beholdes av båt / rederi
Blad 3 - blå:	Beholdes ved lasteplass
Blad 4 - rosa:	Beholdes ved lasteplass

____

Mottakers kvittering

NS-EN 12620 NS-EN 13043 NS-EN 13242

Prosedyre for lasting av skipslaster

Hensikt

Prosedyren skal sikre at produktene skal inneha samme kvalitet fra produksjon til skip samt at skip er lastet med riktig produkt til rett tid. Den skal også sikre at produktene, ved en visuell kontroll, har god nok kvalitet til å kunne kjøres ut av utlaster

Omfang

Prosedyren har gyldighet for all utlasting av anleggets sand produkter til skip

Henvisninger

Lasteplan, lasterapport, rapport for kontroll av skip og lasterom, Bill of loading

Ansvar

Terminalrepresentant/lasteansvarlig

Beskrivelse

Terminalrepresentant/lasteansvarlig skal:

Før lasting

- Sørge for å benytte utlevert verneutstyr (flytevest) ved arbeid på kaien. Gjelder til en hver tid under alle omstendigheter.
- I samarbeid med skipets ansvarlige dekksoffiser planlegge lastingen. (Lastfordeling, lasterekkefølge etc.)
- Kontrollere at lasterommet er rengjort, fylle ut inspeksjonsrapport og påse at denne også blir signert av ansvarlig skipsoffiser.
- Påse at bandtransportørene løper rett og ikke skades av stillestående ruller eller spillhauger av materialer.
- Kontrollere at materne for aktuell(e) sortering(er) er riktig innstilt.
- Ved sjekking av skipningstavlen og event. "Bill of Loading" og forvisse seg om at han planlegger lasting av riktige sorteringer og mengder.
- Ved lasting av sorteringer som er avhengig av mating med hjullaster, forsikre seg om at hjullasterføreren er kjent med sortering og mengde, og avtale prosedyre for lastingen.
- Registrere telleverket på vekten.

Under lasting

- Når flere sorteringer lastes i samme rom, sørge for at disse i minst mulig grad løper sammen.
- For å unngå støvflukt, vannpådusje materialene.
- Visuelt kontrollere at sorteringene er "rene".
- Ved lasting av standard sorteringer og forøvrig etter spesifikk ordre, sørge for at det blir tatt prøver av lasten. Avhengig av lastetidspunkt og hvem som er tilstede, avtaler lasteansvarlig og laborant hvem som skal ta ut prøvene. Se prosedyre for uttak av prøver.
- Hvis stopp under lasting, skal dette registreres. Dette gjelder også hvis stopp er forårsaket av skipet, feks, pumping av ballast. Ventetid pga. skipet, attesteres av skipets kaptein. Skipets agent kontaktes.

Prosedyre for lasting av skipslaster

Avvik i kvalitet under utlasting

Hvis det registreres synbart avvik i kvalitet i form av underkorn eller overkorn, stoppes lastingen og avdelingsleder eller hans stedfortreder kontaktes. Denne avgjør så hvilke tiltak som skal iverksettes.

Skjer registreringen utenom normal arbeidstid og det ikke er mulig å få kontakt med avdelingsleder eller hans stedfortreder, må lasteansvarlig selv avgjøre alternative tiltak.

Disse kan være:

A. Fjerning av det forurensede partiet fra lageret.
B. Laste/mate fra annet lager eller fra annen del av lagerhaugen.
C. Fortsette lastingen utifra den vurdering at forurenset materiale ikke er av en slik mengde at kvaliteten for hele partiet vil overskride tillatte grenseverdier.

Det rapporteres deretter ved første mulighet til avdelingsleder. Det må avgjøres om kunden skal underrettes ved fare for dårlig kvalitet.

Teknisk svikt

Hvis tekniske problemer oppstår i lasteanlegget, kontaktes avdelingsleder eller driftsleder.

Hvis situasjonen oppstår utenom normal arbeidstid og ovennevnte ikke er å få fatt i, må lasteansvarlig selv avhjelpe situasjonen slik:

A. Selv søke å finne og rette feilen.

B. Synes feilen å skyldes elektrisk styring, kontaktes den el.installatør som bedriften benytter til el.service.

C. Synes feilen å skyldes teknisk eller mekanisk feil, kontaktes først driftsleder, eller andre egne folk. Deretter det mekaniske verksted som bedriften benytter til serviceoppdrag av denne art.

D. Informere skipets agent.

Skade som oppstår ved lasting eller lossing

Dersom det oppstår skade på skipets konstruksjon eller utstyr under lasting skal skaden omgående meldes terminalrepresentanten til skipsføreren og eventuelt repareres.

Dersom skaden vil kunne svekke skrogets konstruksjon eller vanntetthet eller skipets vesentlige tekniske systemet, skal skipsføreren underrette i henhold til følgende;

Norske skip: Sjøfartsdirektoratet eller anerkjent klasseinstitusjon

Prosedyre for lasting av skipslaster

Utenlandske skip: Flaggstatens myndighet eller en organisasjon som er godkjent av den og opptrer på dens vegene samt Sjøfartsdirektoratet

Beslutningen om hvorvidt det er nødvendig med umiddelbar reparasjon eller om den kan utsettes, skal treffes av Sjøfartsdirektoratet under hensyn til eventuell uttalelse fra flaggstatens myndighet eller organisasjonen som er godkjent av den og opptrer på dens vegne, samt skipsføreren. Dersom det anses nødvendig med umiddelbar reparasjon, skal den utføres til skipsførerens og vedkommende myndighets tilfredshet før skipet forlater havnen.

Med hensyn til beslutningen nevnt over, kan Sjøfartsdirektoratet la en anerkjent klasseinstitusjon foreta inspeksjon av skaden og gi råd om behovet for å foreta reparasjon eller om den kan utsettes.