



Danish Maritime Accident
Investigation Board

MARINE ACCIDENT REPORT

September 2012



AARSLEFF JACK III / WESTSUND / JOHANNA
Breakdown and collision on 18 December 2011



Danish Maritime Accident Investigation Board

MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

Joint investigation report by the flag State of the United Kingdom and the flag State of Denmark in accordance with the IMO Casualty Investigation Code (resolution MSC.255(84))

This is a joint investigation report by the Danish Maritime Accident Investigation Board as the lead investigation body and the MAIB. The two bodies have conducted this investigation jointly and in accordance with the IMO Casualty Investigation Code.

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Front page: Damage to the hull of JOHANNA, MAIB.

The marine accident report is available from the webpage of the Danish Maritime Accident Investigation Board www.dmaib.dk.

The Danish Maritime Accident Investigation Board

The Danish Maritime Accident Investigation Board is an independent unit under the Ministry of Business and Growth that carries out investigations with a view to preventing accidents and promoting initiatives that will enhance safety at sea.

The Danish Maritime Accident Investigation Board is an impartial unit which is, organizationally and legally, independent of other parties

Purpose

The purpose of the Danish Maritime Accident Investigation Board is to investigate maritime accidents and to make recommendations for improving safety, and it forms part of a collaboration with similar investigation bodies in other countries. The Danish Maritime Accident Investigation Board investigates maritime accidents and accidents to seafarers on Danish and Greenlandic merchant and fishing ships as well as accidents on foreign merchant ships in Danish and Greenlandic waters.

The investigations of the Danish Maritime Accident Investigation Board procure information about the actual circumstances of accidents and clarify the sequence of events and reasons leading to these accidents.

The investigations are carried out separate from the criminal investigation. The criminal and/or liability aspects of accidents are not considered.

Marine accident reports and summary reports

The Danish Maritime Accident Investigation Board investigates about 140 accidents annually. In case of very serious accidents, such as deaths and losses, or in case of other special circumstances, either a marine accident report or a summary report is published depending on the extent and complexity of the accident.

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1. SUMMARY

In the early afternoon of 18 December 2011, the tug WESTSUND was towing the barge AARSLEFF JACK III on an easterly course in the South of Gedser Traffic Separation Scheme (TSS) in the western Baltic Sea.

During the towing operation one spud pile (barge leg) on the barge came loose, lowered itself, hit the seabed and broke off. Later that afternoon, another spud pile came loose and lowered itself to the seabed, resulting in the barge grounding. After an unsuccessful attempt to repair the jack-up unit holding the spud pile, the second spud pile including a pontoon broke off. The tug crew believed that both spud piles and the pontoon were lost and were lying on the seabed.

About three hours after the loss of the second spud pile, the container ship JOHANNA passed the area and collided with one of the spud piles. The spud pile penetrated the hull above the waterline and forecastle deck. The crew did not become aware of the damages until early next morning and JOHANNA diverted to the port of Karlskrona, Sweden, for repairs.

The investigation has established that, on 18 December 2011 at 2300 local time, JOHANNA collided with the second spud pile lost by the barge AARSLEFF JACK III on 18 December 2011 at 2010 local time.

It has not been possible to establish for certain what technical circumstances caused the malfunction of the locking pins holding the spud piles, thereby enabling them to come loose and slide out of the hydraulic jack-up unit. However, the wear of the locking pins, the lacking securing of the spud piles and the area and conditions under which the barge was towed are factors that have, with some likelihood, contributed to the breakdown.

The Danish Maritime Accident Investigation Board has made recommendations to the owner of the barge and the Danish Maritime Authority.

2. FACTUAL INFORMATION

2.1 Photos of the ships



Figure 1: WESTSUND
Source: Svendborg Bugser A/S



Figure 2: AARSLEFF JACK III
Source: MarineTraffic.com



Figure 3: JOHANNA
Source: Christian Costa

2.2 Ship particulars

Name of vessel:	JOHANNA
Type of vessel:	Container ship
Nationality/flag:	United Kingdom
Port of registry:	London
IMO number:	9197521
Call sign:	VQGGQ2
DOC company:	H-G Voge GmbH & Co KG
IMO company no. (DOC):	0219251
Year built:	1999
Shipyard/yard number:	J.J. Sietas KG Schiffswerft & Co./1071
Classification society:	Germanischer Lloyd
Length overall:	121.35 m
Breadth overall:	18.45 m
Gross tonnage:	6,363
Deadweight:	7,131 ton
Draught max.:	6.69 m
Engine rating:	5,300 kW
Service speed:	16.5 kts
Hull material:	Steel

Name of vessel:	WESTSUND
Type of vessel:	Tug
Nationality/flag:	Denmark
Port of registry:	Svendborg
IMO number:	7822421
Call sign:	OUIB2
DOC company:	Svendborg Bugser A/S
IMO company no. (DOC):	0255095
Year built:	1980
Shipyard/yard number:	Richards Ltd., Lowestoft/547
Classification society:	Germanischer Lloyd
Length overall:	33.25 m
Breadth overall:	10.29 m

Gross tonnage:	366
Deadweight:	263 ton
Draught max.:	4.18 m
Engine rating:	1,037 kW
Service speed:	10 kts
Hull material:	Steel

Name of vessel:	AARSLEFF JACK III
Type of vessel:	Barge (pontoon)
Nationality/flag:	Denmark
Port of registry:	Aarhus
Call sign:	OU 7934
DOC company:	Per Aarsleff A/S
IMO company no. (DOC):	1832186
Year built:	1999
Shipyard/yard number:	Ravenstein B.V./106
Classification society:	Germanischer Lloyd
Length overall:	23.42 m
Breadth overall:	17.04 m
Gross tonnage:	246.2
Deadweight:	180 ton
Draught max.:	2.42 m
Hull material:	Steel

2.3 Voyage particulars

Name of ship	JOHANNA
Port of departure:	Antwerp, Belgium
Port of call:	Kokkola, Finland
Type of voyage:	International
Cargo information:	General cargo in containers
Manning:	12
Pilot on board:	No
Number of passengers:	None

Name of ship	WESTSUND/AARSLEFF JACK III
Port of departure:	Gedser, Denmark
Port of call:	Copenhagen, Denmark
Type of voyage:	National
Manning:	5
Pilot on board:	No
Number of passengers:	None

2.4 Weather data

Wind – direction and speed:	Approximately 10 m/s
Wave height:	Approximately 1.1 m
Visibility:	Good
Light/dark:	Light
Current:	Unknown

2.5 Marine casualty or incident information

JOHANNA

Type of marine casualty/incident:	Collision
IMO classification	Serious
Date, time:	18 December 2011
Location:	Baltic Sea western part/traffic separation south of Gedser
Position:	54°24.86' N – 012°10.40' E
Ship's operation, voyage segment	Underway
Place on board:	bow/forecastle
Human factor data:	No
Consequences:	Breach of hull and deck

WESTSUND/AARSLEFF JACK III

Type of marine casualty/incident:	Breakdown
IMO classification:	Serious
Date, time:	18 December 2011
Location:	Baltic Sea western part/TSS South of Gedser
Position:	54°24.88' N – 012°10.18' E
Ship's operation, voyage segment	Underway
Place on board:	Barge structure
Human factor data:	Yes
Consequences:	Loss of two spud piles and damage to hull

2.6 Shore authority involvement and emergency response

Involved parties:	Admiral Danish Fleet Warnemünde VTS MERAC, Germany
Resources used:	None

2.7 The ships' crew

JOHANNA

Master	The master was 62 years old and had spent his entire working life at sea.
Watchkeeping officer	The chief officer was aged 35 and had 13 years' experience at sea on a variety of vessels. It was his first contract working for this company. He joined the vessel on 4 October 2011 and expected to be on board for four months. The chief officer was on watch at the time of the accident. He kept the 0600-1200 and 1800-0000 watches.

WESTSUND/AARSLEFF JACK III

Master	The master was 59 years old and had been employed in the company for the last 11 years. For many years before that, he had been working on fishing vessels.
Watchkeeping officer	The officer of the watch was 52 years old and had been employed with the company for six months. This was his third contract period on WESTSUND. Previously he had been working on tugs with another company and prior to that on general cargo ships.

3. NARRATIVE

3.1 WESTSUND and AARSLEFF JACK III

3.1.1 Background

For more than 20 years, the shipping company owning the tug WESTSUND has performed towing operations for the owner of the barge AARSLEFF JACK III. The towing operations with AARSLEFF JACK III were carried out on a regular basis and were considered a routine task with no apparent extraordinary complexity by the parties involved. Therefore it was not deemed necessary to contract a warranty surveyor to conduct a survey of the barge and towing operation.

Agreements on towing operations between the owner of the tug and the owner of the barge usually have the form of standard BIMCO chartering contracts with the inclusion of the insurers' conditions. There could be restrictions regarding the weather conditions under which to perform the towing operation. This particular towing operation had a weather restriction of 10 m/s, which was a common weather restriction for this kind of towing operation.

3.1.2 AARSLEFF JACK III

The barge AARSLEFF JACK III is a barge used for inshore construction works and is owned and operated by a general infrastructure contractor specialised in engineering and pipe renewal.

The layout of the barge is illustrated in figure 4 below. The illustration to the left shows the barge viewed from above and to the right the barge is viewed from the side with the spud piles in a lowered position.

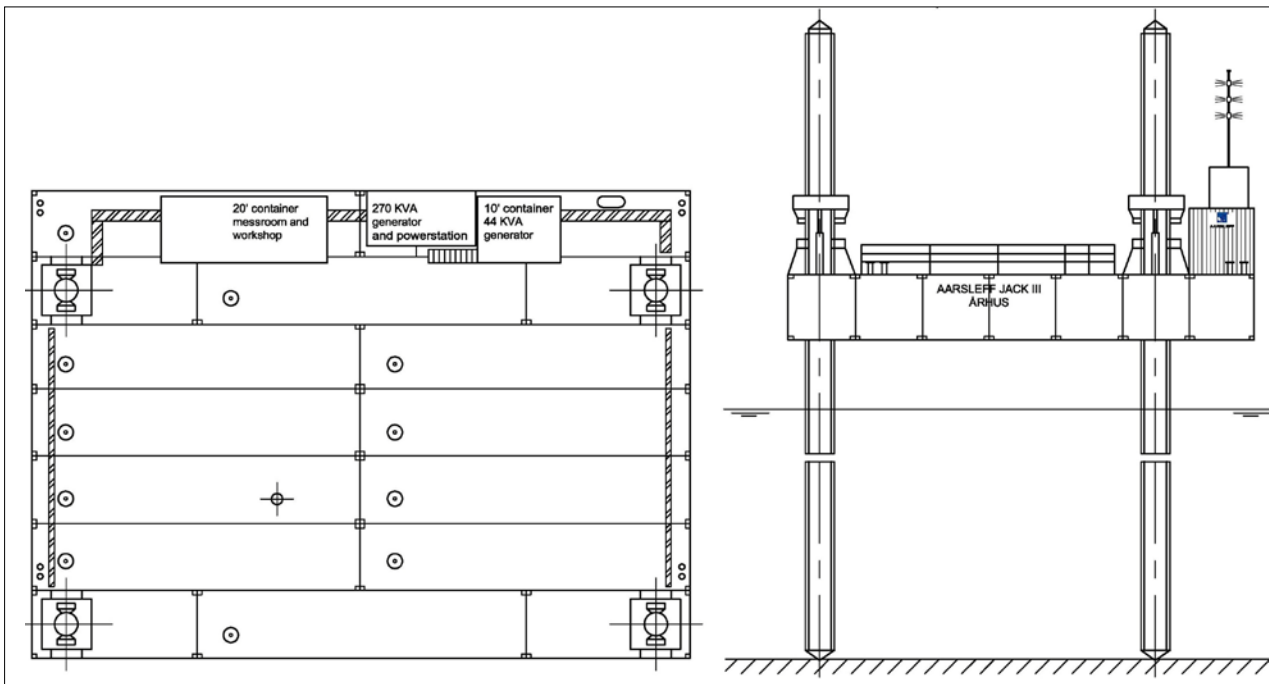


Figure 4: Layout of AARSLEFF JACK III
Source: Aarsleff A/S

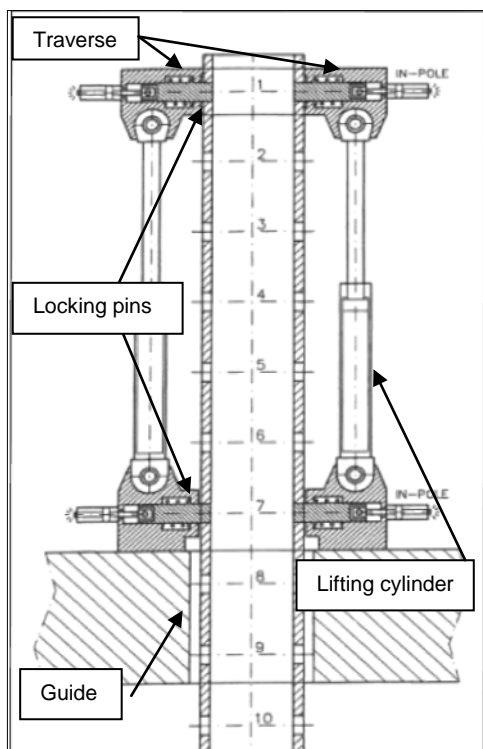
AARSLEFF JACK III is a pontoon barge consisting mainly of a system of 16 coupled pontoons dimensioned as standard containers suitable for e.g. road transportation and four removable hydraulic jacking units.

During normal operation, the pontoons are linked together with dovetail elements which can be disconnected when the pontoons are to float separately.

The barge is approximately 24 metres long and 17 metres wide. It is equipped with four circular spud piles which are 32 metres long and 1.02 metres wide (1.24 metres with the guides on each side). They are made of steel, hollow and pressure tested enabling them to float. Each spud pile weighs approximately 20 tons.

Three containers are mounted on the barge containing a mess room, a generator and a hydraulic power pack.

Four hydraulic jacks are mounted in the corners and are used for hoisting and lowering the spud piles. See figure 5 below.



In the figure, the hydraulic jack and spud pile is illustrated in a locked position.

The four locking pins are pushed into the spud pile by means of steel springs with a force of about 980 N. By applying hydraulic pressure, the pins are brought back and thereby release the spud pile.

The upper traverse (crosshead) is connected to the pontoon by means of two double-acting hydraulic cylinders which lift/lower the piles/barge.

The locking pins and pistons are thus designed to lift and lower the barge and absorb the vertical load of the barge. Any horizontal movements are absorbed by guides in the hydraulic jack unit and on the pontoon.

During wet tow of the barge, the spud piles are brought up and locked by the four locking pins. There are no additional mechanical features to hold the piles during towing operations.

Figure 5: Jack-up unit
Source: Aarsleff A/S

A barge master hired by the owner is responsible for the day-to-day operation of the barge, including maintenance, operation of the hydraulic jacks and securing the equipment before towing to various locations.

This barge did not have a full operation manual as some of the other similar barges operated by the owner. At the time of construction, operations manuals were not commonly supplied with this type of barge, but the company made a short manual on how to operate the hydraulics. Subsequently, new buildings supplied to the owner have been supplied with detailed manuals on the operation and limitations of the barge, e.g. that the spud piles should be removed from the hydraulic jack-up unit and lashed on deck during wet tow.

Surveys of the barge are conducted by the classification society and it is certified for sheltered water service¹. Class certification includes the pontoons, spud piles and hydraulic jack-up unit. The latter is surveyed by performing a function test and a visual inspection.

The Danish Maritime Authority has issued a trading permit for trade within 20 nautical miles of the coast and within the classification society's notation.

3.1.3 WESTSUND and AARSLEFF JACK III – the breakdown

WESTSUND arrived at Gedser, Denmark, on a voyage from Svendborg, Denmark, on 17 December 2011 at 1630 local time. The initial intention was to start the towing operation from Gedser to Copenhagen, Denmark, the same evening. However, after the barge master had arrived at Gedser, at 2000 the same evening, it was agreed to delay the departure until the next morning due to unfavourable weather conditions and the need to carry out repairs of the barge's hydraulic unit.

On the morning of 18 December 2011 at approximately 0900, WESTSUND was connected to the barge. The barge was connected by chains and a wire in a crowfoot to the bollards on the barge so that it would be towed diagonally through the water. This is a commonly used method on long voyages because it presumably minimizes the fuel consumption and enables higher speed when the barge is box-shaped. Furthermore, the method of connecting the barge and the tug usually depends on the position of the bollards on the barge.

As usual, the weather forecast was obtained by radio broadcast and/or the DMI website. On departure, the tug crew observed northwesterly winds of Beaufort force 3-4, but had received a weather forecast reporting increasing wind from southwest force 5-6. By that time, however, the tug was planned to be in a sheltered area at Stevns Klint, east of Sealand, Denmark, and was therefore not supposed to be significantly affected by the increasing winds.

The voyage was planned to go eastward using the traffic separation scheme (TSS) south of Gedser, in Kadetrenden, see figures 6 and 7 below. This decision was primarily based on a reluctance to pass the narrow passage between the traffic scheme and the area south of the Gedser peninsula, thereby getting too close to the southwest bound traffic. During previous towing operations WESTSUND's crew had chosen the inshore area, but only when sailing in the opposite direction, i.e. southwest bound.

After having successfully connected the tug and barge, WESTSUND and AARSLEFF JACK III departed Gedser bound for Copenhagen at 1000 on 18 December 2011. Arrival at Copenhagen was estimated for 19 December 2011.

The length of the towing wire varied according to the general conditions, but at open sea it was 150-200 metres.

At 1200 on 18 December 2011, there was a change of the watch on the bridge. By then, the tug had reached the western entrance of the traffic scheme. At the change of the watch, the wind was observed to be northwesterly force 3-4 and the sea was approximately 0.5-1.0 meter.

At 1315, the officer of the watch noticed a sudden decrease in the speed and he immediately realised that one of the spud piles on the forward part on the port side of the barge was in a lower position than the others. The tug was now eastbound in the southern traffic lane with full speed ahead, which gave a speed of 4-5 knots over the ground. The towing wire was approximately 200 metres and tightening.

¹ This area of service is restricted to trade in shoals, bays, haffs and firths or similar waters, where heavy seas do not occur.

The officer of the watch had an immediate concern about the draught which was estimated to be approximately 18 metres. This estimate was based on the length of the spud pile that remained visible above the jack-up unit. The officer of the watch turned the tug towards the deepwater route, set the propeller pitch to zero and notified the master. See figures 6 and 7 below for the approximate position of the event.

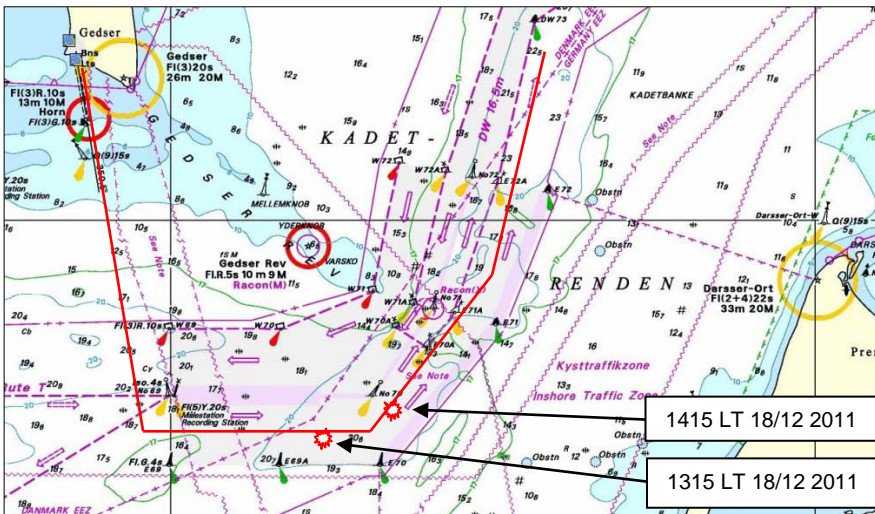


Figure 6: Overview of Kadetrenden
Source: Det Levende Søkort



Figure 7: Overview of Denmark
Source: Google Earth

The master came on the bridge and notified the barge master about the situation by mobile phone. After a short conversation, the barge master informed the master that he intended to embark a pilot boat at Gedser at 1500 on 18 December 2011 that would bring him to the barge so that he could assess the situation and make the necessary repairs.

At this time, the tug and the barge were drifting in an easterly direction. No significant traffic was observed in the area of concern to the master and the officer of the watch.

One hour later at 1415, after WESTSUND had drifted approximately two nautical miles in an easterly direction, the spud pile on the aft starboard side of the barge had slid down so that it was barely visible. The wire was tightening and the crew on the tug soon realized that the barge had grounded and could not be moved. They slacked the wire and positioned the tug upwind.

After the second spud pile had slid down, the barge master was contacted again and informed about the latest development.

On board WESTSUND the situation was considered critical, but it was also realized that the problems with the barge could be solved only by the barge master, who was considered to have the technical knowledge to assess and eventually solve the problems on the barge.

At 1610, the barge master arrived at the barge by the pilot boat from Gedser together with a repairman from a hydraulic company. The weather had deteriorated and the wind was at this time northwesterly force 5 to 6.

While onboard the barge, the barge master and repairman quickly realized that the spud pile on the forward port side had slipped out of the locking pins, had fallen down and had eventually become locked again while moving up and down in the hydraulic jack unit. They managed to lift the spud pile in the normal way in the pins and quickly determined that it was broken off approximately 25 metres from the bottom end.

The aft spud pile on the starboard side had almost fallen out of the hydraulic jack and was slamming the hydraulic jack from beneath. By means of the hydraulic unit, the barge master retracted the locking pins and managed to align the top hole in the spud pile with the lower locking pins. This meant that he could not use the traverse to lift the spud pile any further. It was decided that further equipment was necessary to retrieve the spud pile and therefore the barge master and repairman boarded the pilot boat and went ashore.

At 1910 on 18 December 2011, the crew on WESTSUND informed the Admiral Danish Fleet about the situation and said that they were awaiting the second arrival of the repair team. The Admiral Danish Fleet informed that they would contact MERAC², Germany, and inform them about the situation.

Warnemünde VTS contacted WESTSUND at 1947 on 18 December 2011 and asked for information about why the tug had stopped in the traffic separation scheme. WESTSUND informed the VTS that they had a problem with the spud pile and that they were solving the problems. Warnemünde VTS asked WESTSUND to send warnings on VHF channel 16 to passing vessels. Warning messages were later broadcast by both the VTS and WESTSUND.

MERAC received notification about the incident from the Admiral Danish Fleet at 2007 on 18 December 2011 and relayed the information to Warnemünde VTS at 2012 the same evening. The VTS answered that they were aware of the situation. According to their information, there was no immediate danger to the shipping at that time (2012).

At 2010 on 18 December 2011, the aft spud pile on the starboard side was out of sight and the barge started to drift. Shortly after realising that the barge was not aground any more, the crew on WESTSUND notified the barge master about the situation and told him that there was no need for him to return to the barge.

The pontoon carrying the hydraulic jack-up unit containing the spud pile had broken off. Neither the pontoon nor the spud pile could be seen from the tug and the crew were uncertain if the section was completely lost or was still partly connected to the barge. If so, it was being dragged under water and could ground the barge when they reached shallow waters. Furthermore, the crew were worried about the status of the overall construction of the barge and if it was about to sink.

Warnemünde VTS called WESTSUND again at 2022 on 18 December 2011 for an update on the situation and asked whether there was need for assistance. WESTSUND replied that they were afloat and would resume the voyage in a few seconds.

At 2041, Warnemünde VTS called WESTSUND again for an update. It was reported that everything was well secured and that they would go to a sheltered position near the German coast and wait for better weather. See figure 8 below of WESTSUND's AIS track.

² Maritime Emergency Reporting and Assessment Centre.

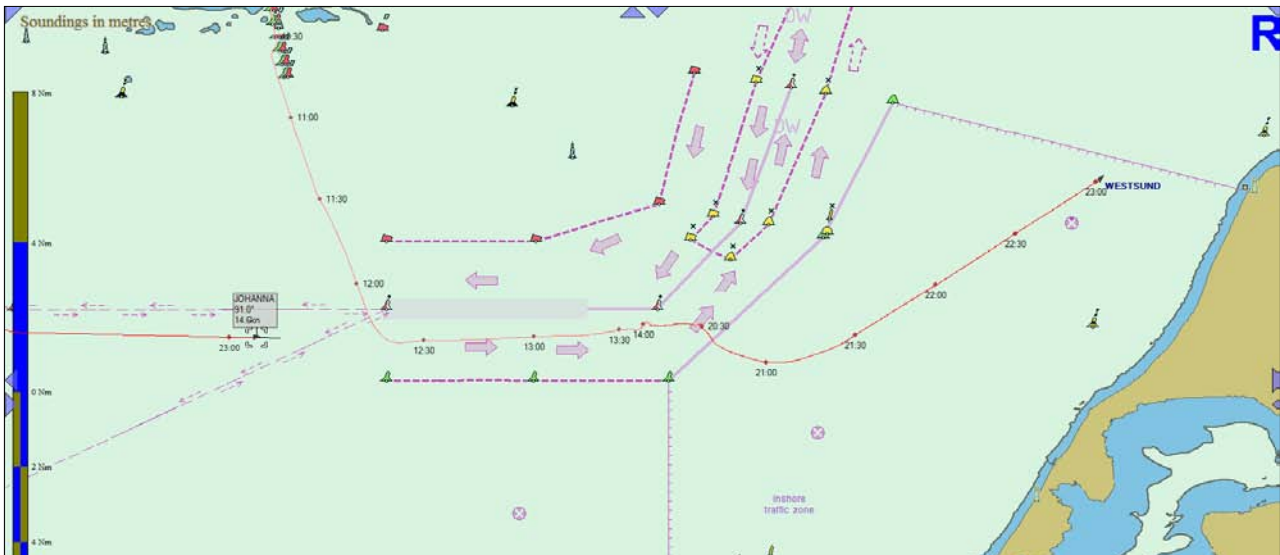


Figure 8: AIS track of WESTSUND
Source: Danish Maritime Authority

On board WESTSUND it was decided to leave the TSS to seek shelter by Darsser Ort, Germany, to assess the damage. If the barge was about to founder, it was deemed better that it sank in shallow waters outside the TSS where it could be retrieved more easily and would not hinder the traffic in the TSS.

The same evening, when passing Darsser Ort, the crew on WESTSUND were certain that the aft spud pile and pontoon were lost because the barge passed a shallow water area off Darsser Ort with no sign of touching the seabed. On the basis of these facts the crew concluded that the spud piles, jack-up unit and pontoon had sunk earlier that evening at about 2010 and were lying on the seabed.

As the weather was deteriorating and the wind changed from northwest to southwest force 6, WESTSUND sought shelter north of the coast of Zingst, Germany. The voyage to Copenhagen, Denmark, was continued on the evening of 19 December 2011.

3.1.4 Retrieval of the spud piles and pontoon

The Admiral Danish Fleet contacted WESTSUND after having received a report from MRCC Göteborg, Sweden, about the damages sustained by JOHANNA.

On 28 December 2011, a search for the missing spud piles and pontoon was initiated by the Waterways and Shipping Directorate and carried out by the Federal Maritime and Hydrographic Agency in Germany. By means of a side-scan sonar, the spud piles were located at approximately 20 metres depth on the positions marked 1315 and 1415 on figure 6.

The first spud pile that broke off was considered to be a danger to shipping because of its location in the TSS and also because it was positioned in a 45° angle about 12 metres below the surface of the sea. The second spud pile, which was still attached to the pontoon, was lying flat on the seabed at about 20 metres depth.

On 31 December 2011, a salvage company on behalf of the owner of the barge retrieved the spud pile that was considered to be a danger to the navigation. The second spud pile with the pontoon attached was retrieved on 9 January 2012. Due to adverse weather conditions, the retrieval of the spud piles was delayed. Both spud piles were brought to the port of Roedby, Denmark, and later to a shipyard at Assens, Denmark, where repairs were carried out.

3.1.5 Damage to AARSLEFF JACK III

The barge had mainly suffered damage to the spud pile and jack-up unit on the forward part on the port side and the pontoon on the aft starboard side that was missing. See the layout of the barge in figure 9 below.

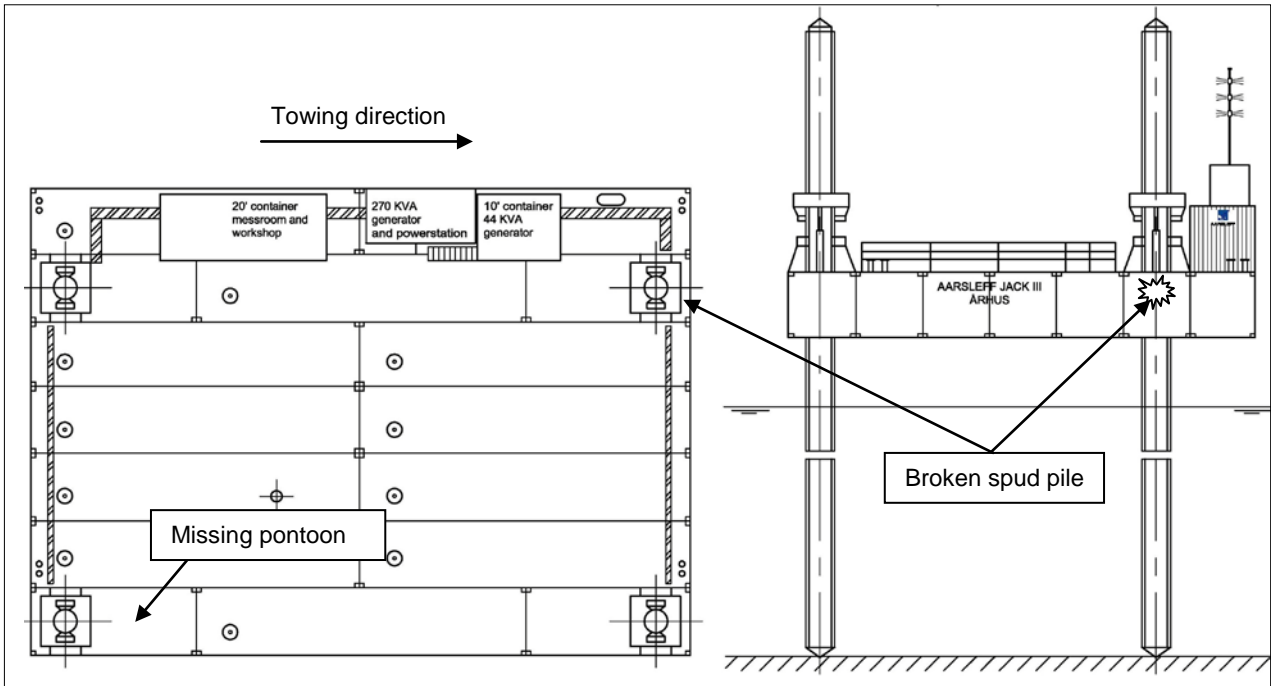


Figure 9: Layout of AARSLEFF JACK III
Source: Aarsleff A/S

The position of the missing pontoon on the barge is seen in figure 10 below. Figure 11 shows a picture of the hydraulic jack-up unit. The forward spud pile seen on figure 11 below was broken off immediately under the jack-up unit approximately 25 metres from the bottom end.

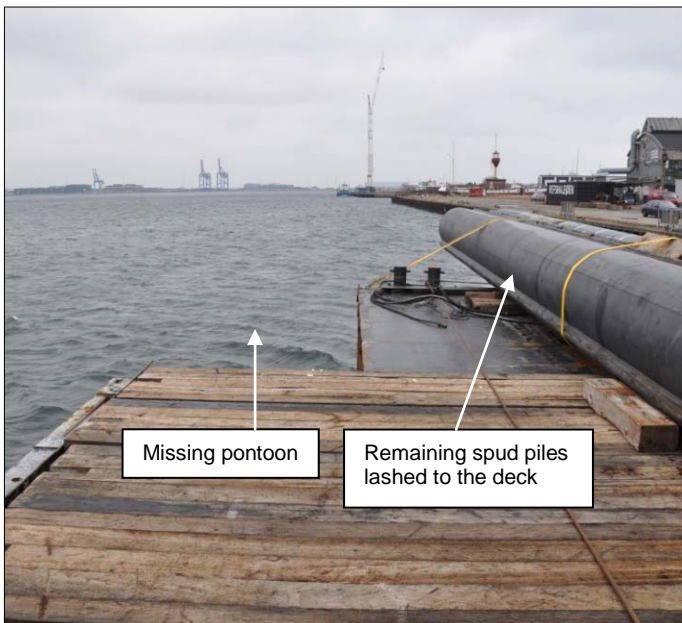


Figure 10: Missing pontoon
Source: DMAIB



Figure 11: Broken spud pile
Source: DMAIB

The pontoon containing the hydraulic jack-up unit and spud pile had broken off and the dovetail elements had been deformed. The aft spud pile, still attached to the pontoon, was bent approximately 4.5 metres from the bottom end. A crack where it was bent enabled the spud pile to be filled with water, thereby losing its buoyancy.

During the breakdown, a hole was torn in the pontoon filling it with water causing the buoyancy to be lost. The traverse was lost and has not been retrieved.

Figure 12 below is a picture of one of the holes in the guide of a retrieved spud pile. The holes in the spud pile guides were, to varying degrees, worn and had become oval. The fact that all the holes were worn to varying degrees indicates that the wear did not originate from the accident.

Figure 13 below is a picture of one of the locking pins. Measurements were made of all the locking pins on the hydraulic jack-up unit (except on the traverse that was not retrieved). These measurements indicated that the pins had suffered considerable wear that was not of a recent date and that had, therefore, been created over a long period of time.



Figure 12: Oval guide hole on retrieved spud pile
Source: DMAIB



Figure 13: Locking pin
Source: DMAIB

The wear varied from 4 mm to 17 mm and had left the pins with a conical shape as opposed to the original cylinder shape. Furthermore, all the locking pins had been bent up to 5 mm in a downward direction.

All the springs that held the locking pins in place were intact and fully functional. They were measured to have a force of approximately 1 kN, equivalent to the new springs. However, the force of the springs apparently did not apply sufficient pressure to give the pins the necessary speed to immediately lock the spud piles while they were moving up and down in the hydraulic jack-up guides.

All lifting cylinder bearings (see figure 11 above) had become deformed, indicating that the traverse had been subjected to excessive horizontal movements.

3.2 JOHANNA

3.2.1 JOHANNA – *The voyage*

JOHANNA departed from Antwerp on 16 December 2011 at 1530 local time bound for Kokkola, Finland. The passage plan took the vessel through the Gedser South Traffic Separation Scheme, South of Gedser in the western Baltic Sea.

The officer of the watch reported entering the TSS at about 2300 on 18 December 2011 local time. There were two vessels on his port side and another two vessels on his starboard side, all travelling in the same direction. The officer of the watch considered that all the vessels were at a safe distance and were following the TSS. At about 2335, the officer of the watch altered JOHANNA's course from 090° to 044° to follow the direction of the TSS.

The officer of the watch considered the quality of the radar picture to be good and he had not experienced any problems in detecting other vessels or navigational marks.

Shortly after having altered the course (estimated 1-2 minutes), the officer of the watch felt JOHANNA shudder and heard a bang. He interpreted this as the vessel slamming into a wave as it settled onto its new course. The officer of the watch did not see or detect anything on the radar suggesting that he had made contact with an object.

The master was woken by the noise/movement and telephoned the officer of the watch to ask what had happened. The officer of the watch reported that he had just altered course and that he thought it was the hull slamming into a wave.

There were no alarms or indications of damage and JOHANNA continued its voyage through the night. At 0800 the following morning, the deck crew started work and began their routine check to see that all the containers on deck were secure. One of the able seamen (AB) found a large hole in the starboard side of the forecastle and the starboard bow. At about 0815, he returned to the bridge and reported the damage to the chief officer.

The AB was in a state of shock and the chief officer informed the master about the damage. The master went to check for himself and returned to the bridge to relieve the chief officer. The chief officer, bosun and deck crew then went forward to patch the hole in the starboard bow with wooden boards.

With no other damage evident, JOHANNA continued its voyage, diverting to Karlskrona, Sweden, for repairs.

3.2.2 *Damage to JOHANNA*

The damages to JOHANNA were confined to the forecastle/starboard bow area. Both holes were above the waterline and there had been only minor ingress of water. Nevertheless, the damage was considerable, penetrating the 10 mm thick deck plating.

The hole in the starboard bow measured 1.2 metres high by 1.35 metres long. It was of a regular elliptical shape. The location of the hole is shown in figures 14 and 15 below.

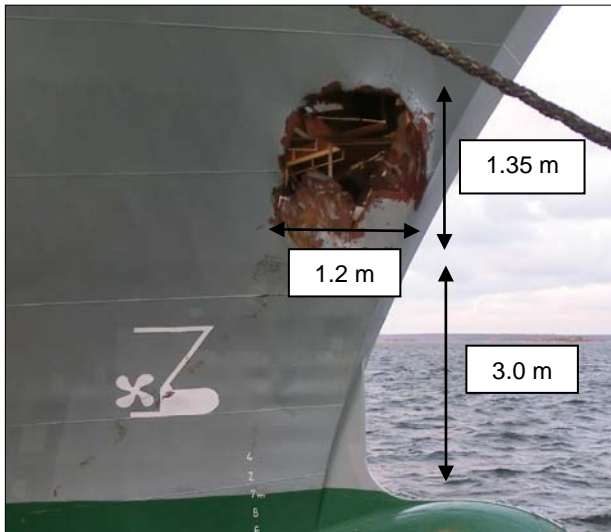


Figure 14: Hole in starboard bow
Source: Reederei H.-G.Vöge GmbH & Co.KG

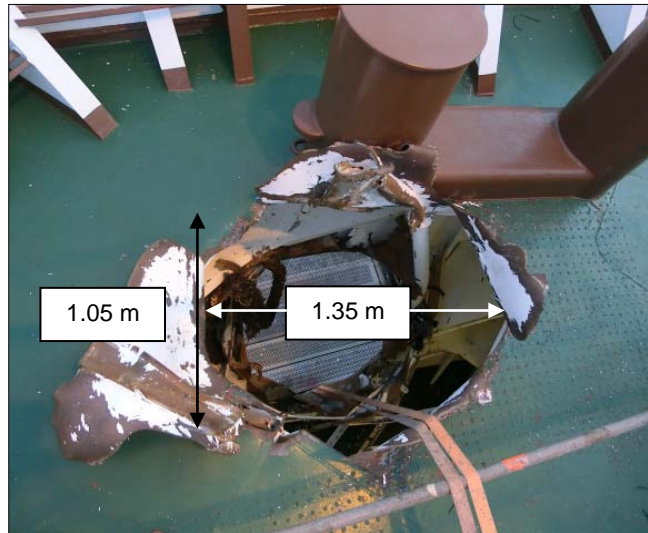


Figure 15: Hole in forecastle deck
Source: Reederei H.-G.Vöge GmbH & Co.KG

The plating around the edge of the hole showed characteristic 'petalling' indicating that the plating had been penetrated from the outside. There was evidence of dark coloured paint residues of a colour different to that of the hull. Samples of these were collected for analysis.

A hole, measuring 1.05 metres wide by 1.35 metres long, had been made in the starboard side of the forecastle deck, see figure 15 above. The deck plating was buckled in an upward direction, indicating that it had been penetrated from below by an object moving in an upward direction.

Overall the damage caused by the impact was substantial, shearing through two substantial steel structures leaving two large, almost circular holes.

3.3 Weather

The Investigation Board has received weather data from the Danish Meteorological Institute (DMI). These data include weather observations from the harbour of Gedser, Denmark, weather forecasts for the Western Baltic and model data from the area at the TSS in the Kadetrenden where the accident occurred. Based on previous observations performed from wave height buoys in the area, the DMI has concluded that, with reasonable certainty, the model data coincide with the actual sea conditions.

The first spud pile came loose at 1315 local time on 18 December 2011. Model data from this period indicate that the wave height was approximately 1 meter with a wind speed of 10 m/s from west-northwest. When the pontoon and second spud pile broke off at 2000 the same day, the model indicated that the wave height was approximately 2 metres with a wind speed of 13 m/s from the west.

Observations from the shore-based weather station at Gedser measured wind speeds of 7 m/s at 1300 on 18 December 2011 increasing to 12 m/s at 2000 the same day.

The 24-hour weather forecast from the DMI for the Western Baltic broadcast on 17 December 2011 at 1600 reported southwesterly to northwesterly winds with wind speeds between 8-13 m/s and gale during the night. In addition showers and some sleet.

On 18 December 2011 at 0500, the forecast reported winds from the west and later the southwest with wind speeds from 8 to 13 m/s. Local showers but otherwise good visibility.

3.4 AIS and VDR data

Figure 16 below shows the AIS track of WESTSUND and JOHANNA from the evening on 18 December 2011.

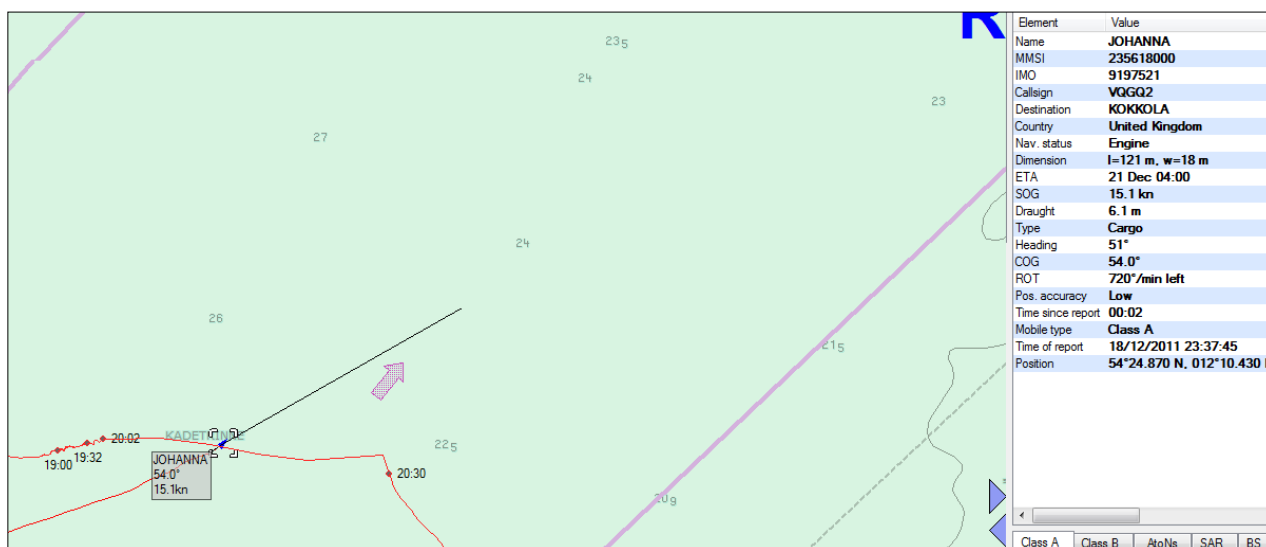


Figure 16: AIS track JOHANNA and WESTSUND
Source: Danish Maritime Authority

The AIS track shows JOHANNA on a northeasterly course on 18 December 2011 at 2337 local time, crossing the track of WESTSUND's easterly course approximately 2.5 hours after WESTSUND was in about the same position.

3.5 Paint analysis

Samples of paint from the damaged areas on JOHANNA were taken for analysis and comparison with paint samples from the spud piles from AARSLEFF JACK III. The engineering consultancy company that performed the paint analysis concluded that small black paint flakes found on JOHANNA had the same overall elemental composition as the spud pile paint and hence the paint probably matches. Furthermore, the grey contaminants found on the barge spud pile has the same overall elemental composition as the grey paint layer from the vessel JOHANNA and hence this paint probably also matches. However, as complete paint layers were not found on the samples from the spud pile or JOHANNA, the consultants cannot be absolutely confident.

4. ANALYSIS

4.1 Loss of the spud piles

The tug had a speed of 4-5 knots when the first spud pile fell down and was dragged along the seabed. As the officer of the watch observed a reduction in speed, he decided to bring the tow into the deepwater route before the barge would ground. It is a likely scenario that the forward momentum of the barge broke the first spud pile off approximately 7.5 metres from the top leaving the remaining part of the spud pile locked in the hydraulic lifting unit. The part that broke off had got filled with water and lost its buoyancy and sank.

When the second spud pile on the starboard side aft on the barge fell down, the barge was drifting and therefore moving at a lower speed. This enabled the spud pile to stop the barge instead of breaking off and the crew on the tug concluded that it had grounded.

As time passed, the increasing severity of the sea conditions and the movements of the loose spud pile created forces beyond the limits of the pontoon and dovetail elements. The pontoon's dovetail elements broke off tearing the metal plating. The pontoon got filled with water in the process and sank. The spud pile was still intact and the buoyancy of the spud pile turned it upside-down leaving the top part with the pontoon on the seabed and the other end above the surface.

The water depth on the location where it was found is about 20 metres and the spud pile is 32 metres long. This left a considerable part of the spud pile above the surface dependent of the angle of the spud pile, see illustration of a likely scenario on figure 17 below.

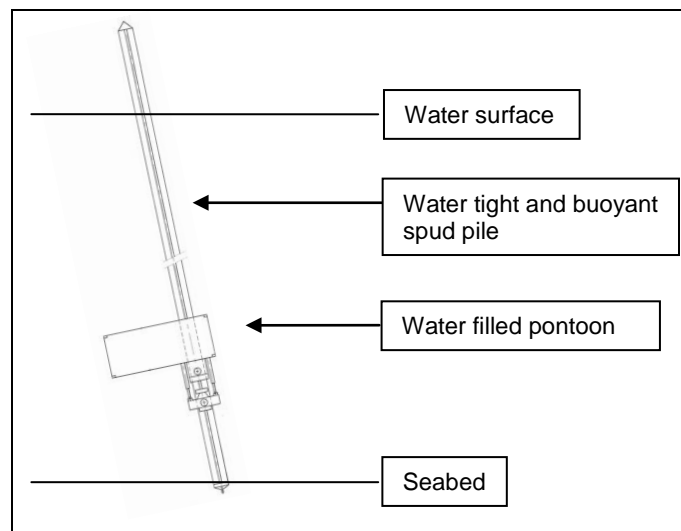


Figure 17: Spud pile on seabed
Source: DMAIB

The investigation did not reveal any certain causes on how or why the spud piles came loose in the first place, but rather some circumstantial indications on contributing factors.

The wear on the locking pins and holes in the guides on the spud piles, making them conical, was created over a long period of time and was not acknowledged and acted upon during the survey from classification society and general maintenance of the barge.

Broken bearings on the lifting cylinders indicated that the jack-up unit had been subjected to excessive horizontal movements on 18 December 2011.

The weather conditions and the area in which the barge was being towed was outside the limits of the classification society's notation and this indicates that the spud piles could have been subjected to forces that made them move excessively.

There was no system in place for stabilizing the spud piles if they were mounted in the jack-up unit while the barge was being towed in open waters. The operational manuals for other barges in the company specifically state that the spud piles should be taken out of the jacks and stowed on deck during wet tow.

It is common to use a weather limitation based solely on wind speed to ensure the safety of the voyage without setting limitations on the wave height. However, wind speeds create wave characteristics dependent on whether it is open waters, close to shore, sheltered waters, etc. It is therefore difficult to predict what wave height and wave period will constitute a danger to the barge under a given wind speed. On 18 December 2011, the wave height and wind speed increased from 1.1 metres and 9 m/s in the morning to 1.9 metres and 13 m/s in the evening when the pontoon

was lost. When using the Beaufort scale, these wind speeds indicate wave heights of 2 and 3 metres.

Whether these wave conditions exceed the design limitations of the hydraulic jack-up unit and its general state of maintenance is unclear.

4.2 Communication and reporting during the breakdown

During the events of 18 December 2011 starting at 1315, the crew on WESTSUND had varying priorities and concerns as they got more knowledge and evaluated the unfolding events.

As the crew realized that the first spud pile had fallen down, the priority was to act upon the increase in the draught due to the spud pile and call the owner of the barge in order to arrange for repairs. At this point in time, the situation was not considered to be critical, but merely an operational disturbance that could be resolved within a short time span.

When the second spud pile fell down, the repair team was already underway. Even though the barge was aground and that the situation was becoming increasingly critical, the crew believed, that the problem could be solved by the repair team by lifting the spud piles and thereby solving the operational problem of the tug. Involving the shore authorities was not considered necessary at this stage.

At 1910, while awaiting the repair team returning with additional equipment, the crew informed the Admiral Danish Fleet about the situation and said that they would relay the message to MERAC. At that point in time, the crew had realized that the situation was deteriorating because the repair team had not solved the technical problems on the barge, the weather was worsening and the barge was still aground.

The three recorded conversations between Warnemünde VTS and WESTSUND indicate that they had considerable difficulty in understanding each other. The VTS operator struggled to get an understanding of WESTSUND's situation and several misunderstandings occurred during the conversation. The predominant problem seemed to be language barriers and, furthermore, the poor audio quality on the VHF transmission was also a factor.

In the final conversation the crew on WESTSUND were certain that the spud piles were on the seabed or that the aft pontoon and spud pile were still attached to the barge, but they did not clearly state this fact in the communication with the VTS. Their primary concern at this time was whether or not the barge was about to founder. It did not seem to be a possibility for the crew of WESTSUND that the steel constructions were able to float.

After the three conversations it is apparent that Warnemünde VTS did not have a full understanding of what had occurred and that debris was afloat in the TSS, and WESTSUND did not report the loss of the spud piles to any authority.

4.3 JOHANNA's collision with the spud pile

The investigation has established that the noise heard on the bridge of JOHANNA as stated by the officer of the watch came from the collision with the broken spud pile that was still attached to the pontoon. Given the weather conditions and specifically the sea state, time of day and profile of the spud pile, it would have been difficult for the officer of the watch to detect the debris in the water by means of radar and/or visually.

From JOHANNA's VDR recording, a loud noise is heard at 2337 local time shortly after altering course to port. JOHANNA's position at this time is about the same as that where WESTSUND lost

the second spud pile with the pontoon and where the spud pile was later retrieved. All three positions are within 0.15 nautical miles of each other.

On 18 December at 2337, JOHANNA crossed the AIS track of WESTSUND, giving a time span of about 3.5 hours. The spud pile was attached to the pontoon that was not floating. Therefore, the weather and current would not move it considerably from the position where it broke off the barge.

The extent and nature of the damage on JOHANNA is well in accordance with the dimensions of the spud pile. Furthermore, it was found bent about 4.5 metres from the bottom end leaving a crack enabling it to be filled with water and sink after the collision.

The paint analysis gives strong circumstantial information that the spud pile had been in contact with JOHANNA.

4.4 AARSLEFF JACK III/WESTSUND organisation and regulation

When organizing and planning a towage operation, the owner of AARSLEFF JACK III and the owner of WESTSUND use a commercial standard towage agreement from BIMCO³. It sets out the conditions and circumstances of how the towage operation is to be carried out. In part II of the standard agreement it is stated that the hirer (owner of the barge) must arrange for all necessary permits, licences and authorisations. Furthermore, the hirer shall exercise due diligence to ensure that the tow is fit for the voyage⁴.

Before departure the barge was made ready for the voyage by the barge master, who was considered a competent and responsible person by the crew on WESTSUND.

During the events on 18 December 2011, the crew on WESTSUND had the perception that the problems that arose on the barge were primarily an issue for the owner of the barge and that it was their responsibility to solve it as reflected in the standard agreement.

When the events unfolded, the concern of the crew was primarily in relation to WESTSUND. This is indicated by the communication with the Warnemünde VTS. When the VTS asked if they had any problems, the crew stated that everything was in order, in the sense that WESTSUND did not have a problem – but the barge did.

When the barge master boarded the barge in open sea with the aim of repairing the jack-up unit, he was considered a representative of the owner and not a part of the crew on WESTSUND. Therefore the risks associated with a person with no maritime background boarding and repairing a barge in adverse weather conditions was not systematically evaluated or acted upon by the crew of WESTSUND.

The barge's certificates and trading permit were not considered when the crew on WESTSUND were planning the voyage from Gedser to Copenhagen. They were seen to be within the scope of the standard agreement between the owner of WESTSUND and the owner of the barge.

In Danish maritime legislation, a barge, with regard to its construction and operational use, is to be considered a ship if it has a certificate of nationality and thereby other certificates as applicable, e.g. a trading permit, safety certificate, MARPOL certificate, etc. It is the commercial use that determines if a barge is required to have a certificate of nationality. If so, the master of the tug becomes the master of the barge with the obligations it entails.

³ International Ocean Towage Agreement (TOWCON 2008).

⁴ TOWCON 2008, part II, sections 17 and 18.

With regard to the technical aspects of the regulation, there is a reference to the regulation covering cargo and passenger ships. This concept has, from an operational point of view, proved difficult to implement for the owners of barges and tugs.

5. CONCLUSIONS

The investigation has established that, on 18 December 2011 at 2337 local time, JOHANNA collided with the second spud pile lost by the barge AARSLEFF JACK III on 18 December 2011 at 2010 local time.

It has not been established for certain what technical circumstances caused the malfunction of the locking pins, thereby enabling the spud piles to come loose and slide out of the hydraulic jack-up unit. However, the wear of the locking pins and guide holes, the lacking securing of the spud piles and the area and conditions under which the barge was towed are factors that most likely contributed to the breakdown.

The ineffective communication between WESTSUND and Warnemünde VTS left the VTS operator with an incomplete understanding of the situation that WESTSUND and AARSLEFF JACK III were in. The predominant cause of the ineffective communication was language barriers and poor audio quality on the VHF transmission. Furthermore, the developing concerns and priorities by the crew on the tug resulted in a situation where they did not have a full overview of the situation and therefore failed to make an accurate reporting of the situation.

Even though the crew on WESTSUND communicated with the Admiral Danish Fleet and Warnemünde VTS, there was no specific information about the loss and none of the authorities became aware that the spud piles were lost.

The fact that the towing operation was subject to a commercial standard agreement describing responsibilities different from those of Danish national regulations, which it was, furthermore, difficult to implement, leaves the owners and ship crew in a situation where they will, from an operational point of view, over time adapt the limits of their responsibilities according to their practices.

This means that, if the standard agreement states that the owner of the barge is responsible for the certification and seaworthiness of the barge, then the crew of the tug will distance themselves from having the responsibility for the barge's limitations and leave it to the owner. Therefore, unless specifically specified in the agreement, the crew of the tug will choose the route they find best from a navigational point of view and not base it on the structural limitations of the barge.

6. SAFETY RECOMMENDATIONS

The Danish Maritime Accident Investigation Board recommends that the Danish Maritime Authority, when further developing the regulation and guidance on barges, focuses on clarifying the role of tug masters in relation to the tow.

The Danish Maritime Accident Investigation Board recommends that the owner of AARSLEFF JACK III, in co-operation with the manufacturers of the barges, supplies the barges having no operational manuals with suitable manuals that cover the subject areas already included in the existing manuals for other barges within their fleet. Furthermore, it is recommended that the owner, in co-operation with the relevant classification society and manufacturer, reviews the scope and method of the maintenance and check of the jack-up units.