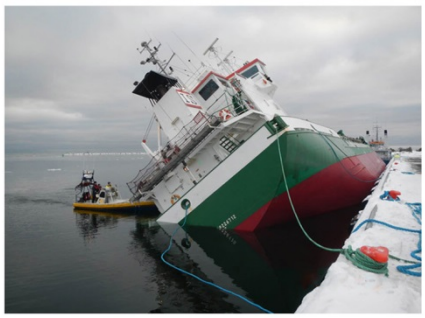
Statens haverikommission
Swedish Accident Investigation Authority



Final Report RS 2017:05e

ASKÖ – Grounding at Hässelby holme, Stockholm County, Sweden, on 9 December 2016

File no. S-205/16

15 November 2017

SHK investigates accidents and incidents from a safety perspective. Its investigations are aimed at preventing a similar event from occurring in the future, or limiting the effects of such an event. The investigations do not deal with issues of guilt, blame or liability for damages.

The report is also available on SHK's website: www.havkom.se

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This document is a translation of the original Swedish report. In case of discrepancies between this translation and the Swedish original text, the Swedish text shall prevail in the interpretation of the report.

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Content

General observations

The Swedish Accident Investigation Authority (Statens haverikommission – SHK) is a state authority with the task of investigating accidents and incidents with the aim of improving safety. SHK accident investigations are intended to clarify, as far as possible, the sequence of events and their causes, as well as damages and other consequences. The results of an investigation shall provide the basis for decisions aiming at preventing a similar event from occurring in the future, or limiting the effects of such an event. The investigation shall also provide a basis for assessment of the performance of rescue services and, when appropriate, for improvements to these rescue services.

SHK accident investigations thus aim at answering three questions: *What happened? Why did it happen? How can a similar event be avoided in the future?*

SHK does not have any supervisory role and its investigations do not deal with issues of guilt, blame or liability for damages. Therefore, accidents and incidents are neither investigated nor described in the report from any such perspective. These issues are, when appropriate, dealt with by judicial authorities or for example by insurance companies.

The task of SHK also does not include investigating how persons affected by an accident or incident have been cared for by hospital services, once an emergency operation has been concluded. Measures in support of such individuals by the social services, for example in the form of post crisis management, also are not the subject of the investigation.

The investigation

SHK was informed on 9 December 2016 that a serious marine casualty had occurred involving the vessel ASKÖ, registration number D5MJ7, off Hässelby holme, Stockholm County on the same day at 04:50.

The accident has been investigated by SHK represented by Mrs Helene Arango Magnusson, Chairperson, Mr Dennis Dahlberg, Investigator in Charge, Mr Mikael Sjölund, Operations Investigator, and Mr Alexander Hurtig, Investigator Behavioural Science.

The investigation team of SHK was assisted by Ms Linda Eliasson, accredited representative of the Swedish Transport Agency, Ms Åsa Holm, accredited representative of the Swedish Maritime Administration and Ms Anna Berglund, accredited representative of the Swedish Coast Guard.

Investigation material

Interviews have been conducted with crew members of ASKÖ, the pilot who was on board at the time of the grounding, pilotage planning personnel and several pilots from Södertälje Pilotage Area, the head of Södertälje Pilotage Area, the Swedish Transport Agency's inspector and personnel from Stockholm Vatten.

A meeting with the interested parties was held on 18 May 2017. At the meeting SHK presented the facts discovered during the investigation, available at that time.

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Ship particulars

Flag state /register	Liberia
Identification	ASKÖ
IMO number /call sign	9333450/D5MJ7
Vessel data	
Type of ship	General cargo vessel
New building shipyard/year	Bodewes Scheepswerven B.V. /2005
Gross tonnage	3,183
Length, over all	89.94 metres
Beam	15.20 metres
Draft,	5.70 metres
Deadweight at max draft	4,508 tonnes
Main engine, output	MAK 6 M 25, 1,850 kW
Propulsion arrangement	One variable-pitch propeller
Lateral thruster	Bow thruster 300 kW
Rudder arrangement	Conventional rudder
Service speed	12 knots
Ownership and operation	Hartmann Reederei
Classification society	DNV GL
Minimum safe manning	8

Voyage particulars

Ports of call	Ust-Luga, Russia–Hässelby
Type of voyage	International
Cargo information	3,979 tonnes of pellets
Manning	8

Marine casualty information

Type of marine casualty	Grounding
Date and time	9 December 2016 at 04:50
Position and location of the marine casualty	59˚ 21,37N 017˚49,78E
Weather conditions	Wind: WSW 3.5 m/s
Other factors	
Consequences	
Injuries	None
Environment	None
Vessel	Hull damage

SUMMARY

ASKÖ had loaded pellets in Ust-Luga, Russia, for transport to Hässelby in Sweden. The vessel had ordered a pilot from Landsort to Hässelby and the pilot boarded at Landsort on 8 December at 22:30.

The vessel passed Nockeby Bridge at 04:31, at which point the pilot announced that they had approximately half an hour remaining to Hässelby. The master came up onto the bridge at the same time. After Nockeby Bridge, the pilot set the course to 309° on the autopilot and in doing so steered straight toward the red buoy at Hässelby holme. The pilot began reducing speed when ASKÖ had approximately 1 M[1] remaining to Hässelby holme and simultaneously switched over to manual steering.

When ASKÖ was to pass the sound between the mainland and Hässelby holme, the pilot discovered that the vessel was on the wrong side of the buoy. He stopped the engine, but was not able to turn before the vessel ran aground. The time was then around 04.50. When it ran aground, the vessel also hit a water pipe from Lovö Waterworks that crossed the fairway under the water.

The accident resulted in extensive damage to the vessel's hull and to the aforementioned water pipe and its supporting structure.

The cause of the accident was shortcomings in the monitoring of the navigation.

Other factors that have contributed to the occurrence:

- The lack of satisfactory bridge cooperation between the pilot and the crew.
- No voyage plan had been made by the vessel's crew for the final part of the voyage.
- The vessel lacked charts for the final part of the voyage.

Against a background of a built-up sleep deficit, the time of day, the long pilotage and the lack of opportunities for rest and recovery, it is also probable that the pilot's level of alertness has been adversely affected by fatigue at the time of the grounding. This has led to insufficient vigilance, which in turn may have contributed to the fact that the pilot did not discover in time that the vessel was on the wrong side of the buoy.

One important underlying factor is the pilots' irregular working hours and rest periods, which make it difficult to plan for rest and thus also to obtain proper periods of continuous sleep.

[1] M – nautical mile. 1 M = 1,852 metres.

Safety recommendations

The Swedish Maritime Administration is recommended to:

- Review its methods for scheduling in order to, if possible, shorten the pilotages that exceed 3–4 hours. (See section 3.3.3) *(RS 2017:05 R1)*

- Investigate how it may be possible to increase the regularity of pilots' rest periods while on duty. (See section 3.3.2) *(RS 2017:05 R2)*

- Develop guidelines or other assessment support for the decision of the pilots to refuse pilotage in case a vessel is not deemed to be seaworthy. (See section 3.3.1) *(RS 2017:05 R3)*

1. FACTUAL INFORMATION

1.1 Sequence of events

1.1.1 Circumstances concerning the voyage

ASKÖ had loaded pellets in Ust-Luga, Russia, for transport to Hässelby in Sweden. Prior to departure, the second officer had made a voyage plan, which the master had approved. The route went from Ust-Luga via Landsort (see Figure 1), where the vessel was to take on a pilot, and then on to Södertälje. However, the voyage plan did not include the final part of the voyage as ASKÖ lacked charts for the voyage between Södertälje and Hässelby. The master had ordered the charts in question in Kotka in Finland on 29 November 2016, but had not received them.

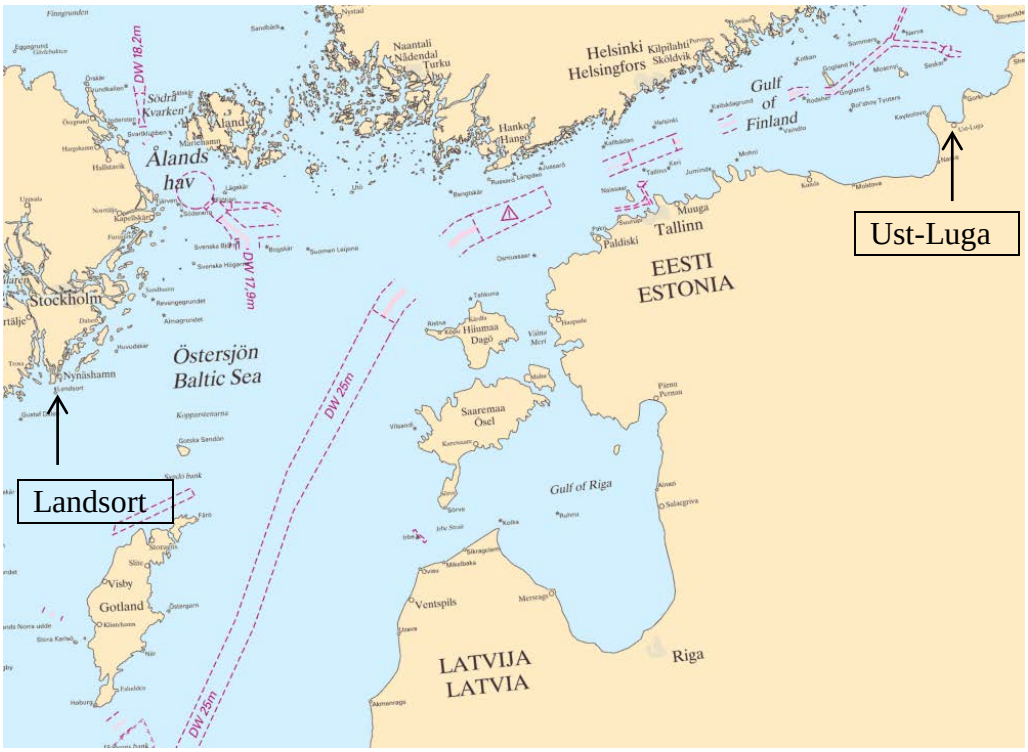

Figure 1. © The Swedish Maritime Administration no. 10-01518.

1.1.2 The circumstances for the pilot

It was the pilot's third working day and the third night in a row that he had piloted on the shift in question. On 6 December, he had been on assignment (including travel to and from the pilotages) between 08:00 and 14:00. On 7 December, he was on assignment first between 00:30 and 08:50 and then again in the evening from 22:00 until 05:30 on 8 December. On the evening of 8 December, he was called at 20:00 in order to be transported out to Landsort, where he boarded ASKÖ at 22:30.

1.1.3 The voyage

ASKÖ departed from Ust-Luga on 7 December at 07:30 loaded with 3,979 tonnes of pellets. When the vessel arrived at the boarding point for pilotage at Landsort, she had a current draught of 5.70 metres.

The master had ordered a pilot from Landsort to Hässelby. When the pilot came on board at 22:30, the pilot and the master went through the voyage together and discussed the mooring operation in Hässelby. The pilot connected his computer, the contents of which included applicable charts, to the vessel's pilot plug[2]. On the way into Södertälje, the pilot checked the compass using the leading line at Brandalsund. The compass deviation was one degree.

ASKÖ was moored in Södertälje Lock at 02:10 and the vessel departed Södertälje at 02:15 with the same pilot on board. The master left the bridge after the lock. The bridge was then manned by the second officer and the pilot. The vessel passed Nockeby Bridge at 04:31, at which point the pilot informed the vessel's chief officer, who had come on watch at 04:00, that they had approximately half an hour remaining to Hässelby. The master came back up onto the bridge at the same time.

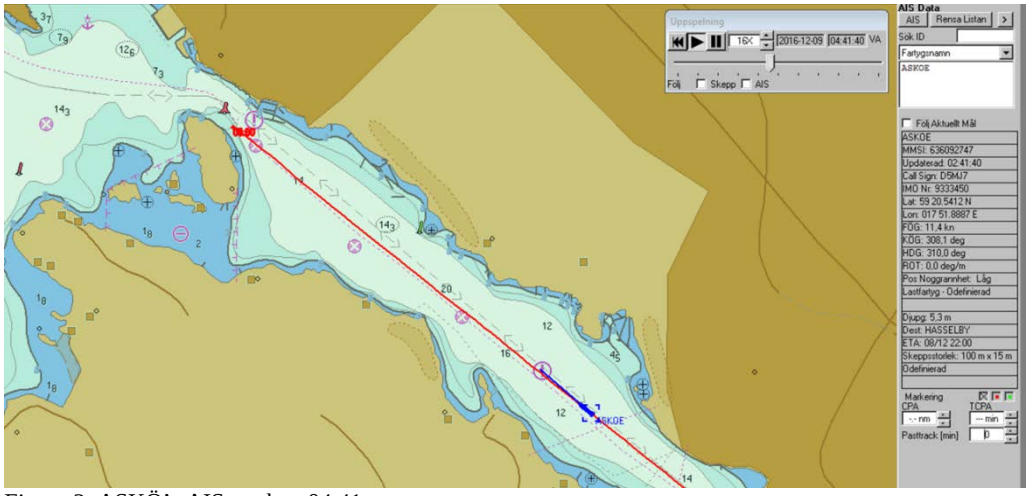

Figure 2. ASKÖ's AIS track at 04.41.

After Nockeby Bridge, the pilot set the course to 309° on the autopilot and in doing so steered in the direction of the red buoy at Hässelby holme. The pilot began reducing speed when ASKÖ had approximately 1 M[3] remaining to Hässelby holme. He simultaneously switched over to manual steering because the propeller is in a nozzle[4] and the vessel's manoeuvrability is impaired at lower speeds. When ASKÖ was to pass the sound between the mainland and Hässelby holme, the pilot discovered too late that the vessel was on the wrong side of the

[2] The pilot plug makes it possible to connect portable devices to the vessel's AIS system.
[3] M = nautical mile. One nautical mile is equivalent to 1,852 metres.
[4] A nozzle is a large steel ring that can be placed around the propeller. In simplified terms, the nozzle provides increased propulsive force.

buoy. He was not able to turn, but stopped the engine before the vessel ran aground at about 04.50.

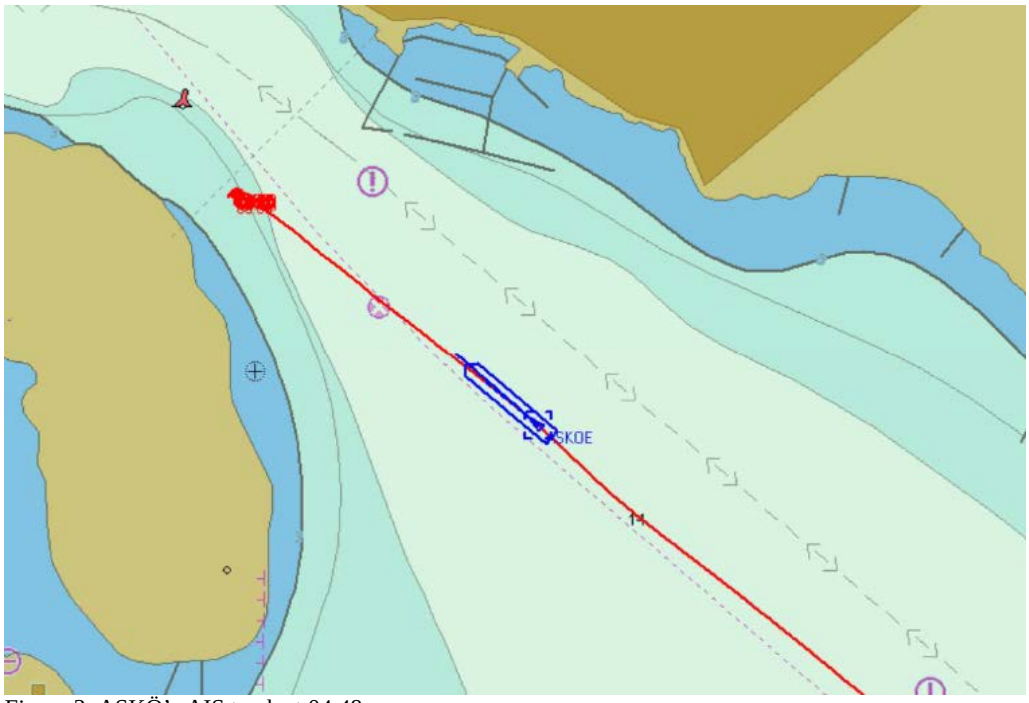

Figure 3. ASKÖ's AIS track at 04.48.

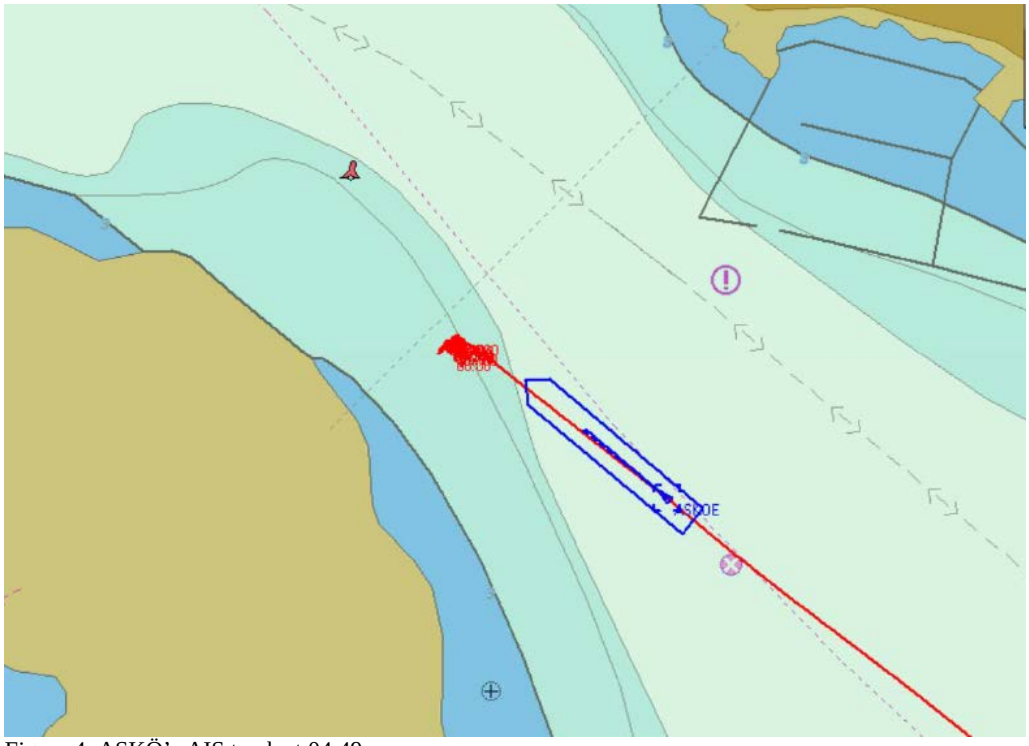

Figure 4. ASKÖ's AIS track at 04.49.

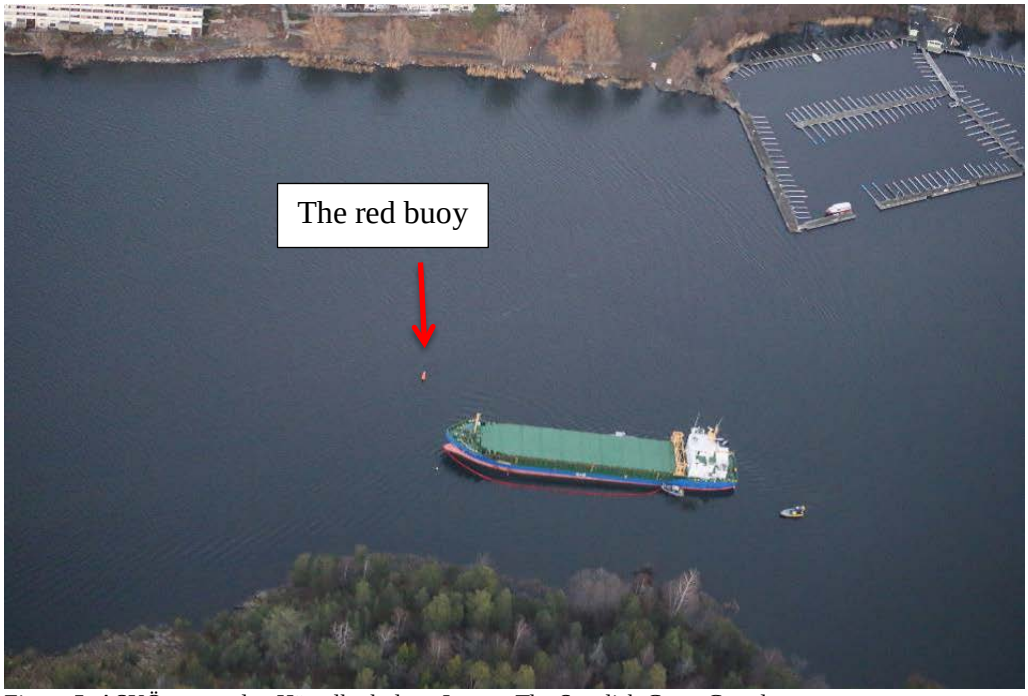

Figure 5. ASKÖ aground at Hässelby holme. Image: The Swedish Coast Guard.

1.1.4 Actions after the grounding

Immediately after the grounding, the pilot called VTS[5] Södertälje on the phone and informed them that the vessel had run aground. The JRCC[6] learned of the grounding at 05:00 via VTS Södertälje and made contact with the vessel via VHF[7] at 05:05. Immediately after the call with ASKÖ, the JRCC also contacted the Swedish Coast Guard's command and control centre and the Swedish Transport Agency's duty officer (TiB).

The Swedish Maritime Administration sent out a new pilot in order to relieve the pilot who had been on board at the time of the grounding. The replacement pilot was on board at 07:00. The Coast Guard sent out several units to the vessel and the Transport Agency placed an surveyor on board. The surveyor was on board at 08:00. He checked the extent of the damage and the vessel's stability together with the crew of ASKÖ and requested a salvage plan from the shipping company.

The Coast Guard's divers began diving to inspect the vessel at 11:03. They discovered that the whole of the vessel's bow section was aground, along with approximately 30 metres aft of the bow. The bottom on the vessel's starboard side consisted of stones of varying sizes, some of which were pushed up into the hull. The divers also discovered that ASKÖ had driven into two cables and that she was sitting on

[5] VTS (Vessel Traffic Service) – centres that provide traffic information and services to shipping.
[6] JRCC (Joint Rescue Coordination Centre) – Air-sea rescue centre, which is part of the Swedish Maritime Administration.
[7] VHF (Very High Frequency) – radio communication system.

a water pipe that belonged to Stockholm Vatten[8] (see Figure 6). More information can be found in section 1.5.

After the dive, it was decided that ASKÖ would be stabilised by means of both of her anchors, one additional anchor and a mooring rope to the shore on Hässelby holme. Prior to the salvage operation beginning, several conversations took place between various parties, among them the Transport Agency, the Coast Guard, the county administrative board, Stockholm Vatten, the shipping company and the classification society. The classification society also had an inspector on board.

The anchors were heaved on Saturday 10 December at 13:00 and the lighterage[9] of ASKÖ began at 13:20. The lighterage was ended for the day at 19:05, by which time approximately 500 tonnes of cargo had been offloaded. The work was resumed at 08:00 on Sunday 11 December. The crew began by attempting to open cargo hatches 1–2, but they were stuck and could not be moved. Instead, they began offloading at 11:20 from hatches 4–5. When the lighterage was terminated at 16:25, a total of approximately 1,000 tonnes had been offloaded. Preparations to tow ASKÖ free began at 17:20, but she was still stuck on her port side at L/2[10]. The Transport Agency's emergency surveyor immediately stopped the attempts to tow the vessel free. The crew then made a new attempt to open hatches 1–2, succeeded in doing so at 19:25 and were then able to begin lighterage from there. At 01:50 on Monday 12 December, after a total of approximately 1,200 tonnes of cargo had been offloaded, ASKÖ came free of the ground and was able to move to the quay in Hässelby.

[8] Stockholm Vatten is now known as Stockholm Vatten och Avfall and is the organisation responsible for water and sewerage in the Stockholm area.
[9] Lighterage involves cargo being transferred from one vessel to another.
[10] L/2 – half the length of the vessel.

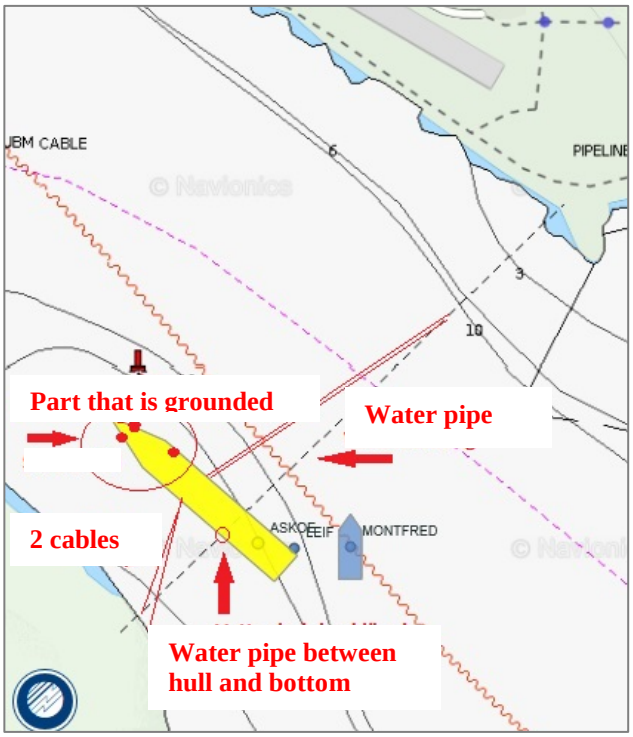

Figure 6. ASKÖ's position after the grounding. Image: The Swedish Coast Guard.

1.2 Injuries

No injuries occurred.

1.3 Oil spillage

The grounding did not cause any oil spillage at sea.

1.4 Damage to ship

The following damage was noted at Remontowa Shiprepair Yard in Gdansk, Poland, where the vessel was repaired after the occurrence:

- Forepeak between frames 121 and 113: several large indentations and holes.
- Bow thruster room from frames 113 to 110: cracks and holes.
- Deep tank from frames 110 to 104: several large indentations and holes.
- Double bottom 1 port from frames 104 to 88: several large indentations and holes.
- Double bottom 1 starboard from frames 104 to 88: several large indentations and holes.
- Double bottom 2 port from frames 88 to 70: several large indentations and holes.

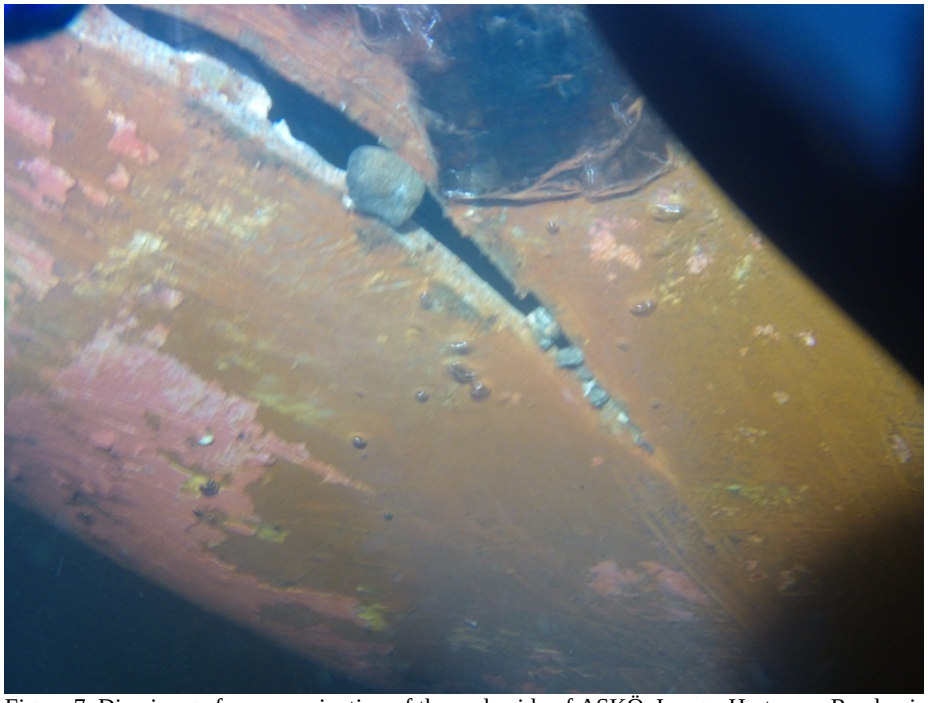

Figure 7. Dive image from examination of the underside of ASKÖ. Image: Hartmann Reederei.

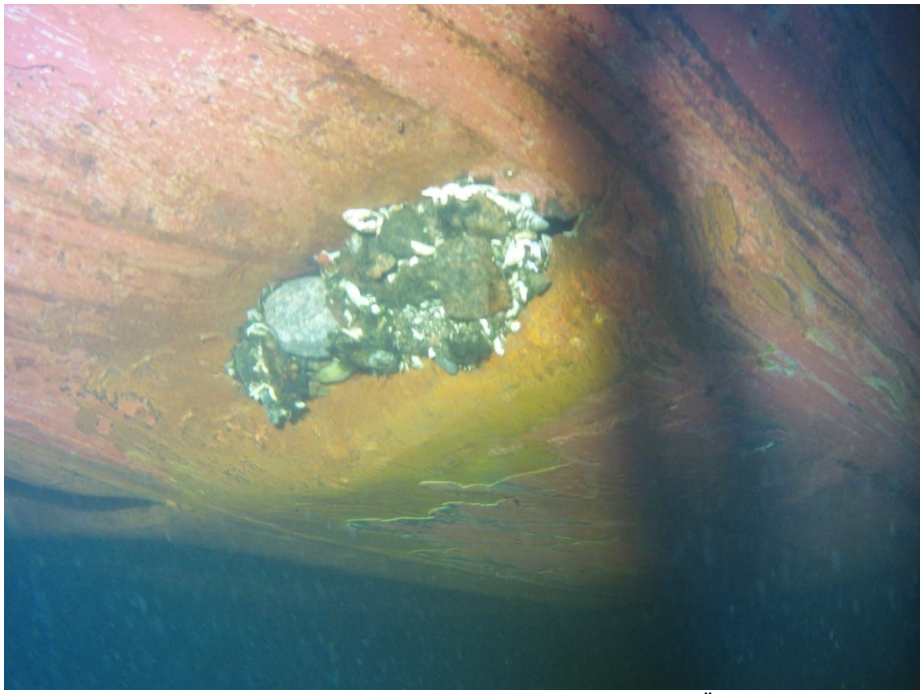

Figure 8. Dive image from examination of the underside of ASKÖ. Image: Hartmann Reederei.

Hull damage had to be repaired and a total of 19 tonnes of steel had to be replaced while at the yard in Poland between 14 December 2016 and 9 January 2017.

1.5 The damaged water pipe

1.5.1 General information about the water pipe

The water pipe in question is one of Stockholm Vatten's feeder pipes from Lovö Waterworks in Lake Mälaren. The pipe extends from Lovö Waterworks, which is on the western side of the island of Lovön, across the island to Hässelby holme. From there, the pipe proceeds underwater across to the mainland at Hässelby. The pipe has a diameter of approximately one metre and is located in a wooden structure on the lake-bed (see Figure 9). The pipe lines at a depth of approximately 6.5 metres in the fairway. Out of the fairway and at the place where the grounding occurred, the pipe is on a shallower depth.

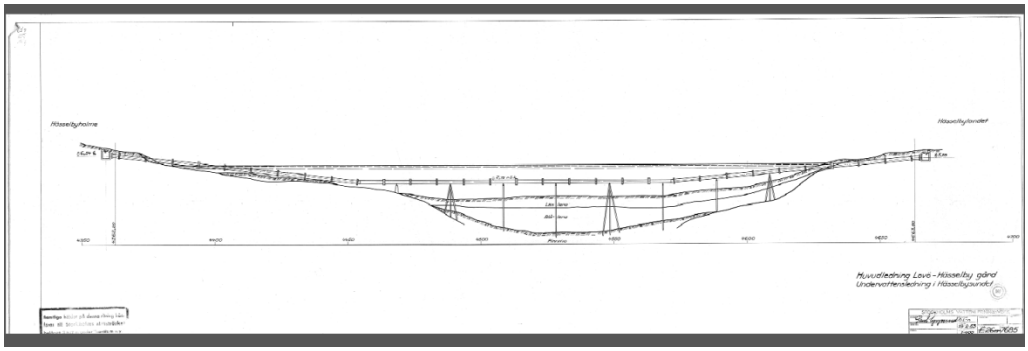

Figure 9. The location of the water pipe on the lake-bed in the fairway. Image: Stockholm Vatten.

The supporting structure for the water pipe is made of wood and was built some time in the 1950s. It has been inspected and repaired by Stockholm Vatten at specific intervals. The water pipe rests on a number of crossbars that support its weight. A number of steel loops around the pipe then hold the water pipe down against the wooden structure.

1.5.2 Damage to the water pipe

The grounding caused damage to a number of crossbars in the supporting structure (see Figure 10). Three of the wooden beams on which the water pipe was resting were split when the pipe "sprang down" due to the weight of the vessel. According to a dive inspection conducted subsequently by Stockholm Vatten, the water pipe has then sprung back up and become partly free hanging in the water. Some superficial damage also occurred to the water pipe itself and to its protective insulation (see Figure 11).

1.5.3 Stockholm Vatten's action as a result of the grounding

Stockholm Vatten learned of ASKÖ's grounding early in the morning of 9 December 2016, when personnel within the company tuned in to the morning news broadcasts. Quite quickly the conclusion was drawn that the vessel could be aground in the area where Stockholm Vatten had one of its large water pipes from Lovö Waterworks.

The company organised its on-call organisation at the same time as more facts about the occurrence were obtained. After a while, they made contact with the Coast Guard vessel which had already been alerted and where on site, which confirmed that it was highly probable that the vessel had run over the water pipe or was grounded on it. The Coast Guard also confirmed that the vessel was not leaking oil. Following this, Stockholm Vatten's crisis management was activated in order to be well prepared for any negative consequences of possible damage to the water pipe.

Stockholm Vatten maintained regular contact with the Coast Guard throughout the day and eventually also received a report on the Coast Guard's dive on the vessel, confirming that ASKÖ was grounded on the water pipe. For preventive purposes, Stockholm Vatten then made the decision to take the water pipe out of operation. At the same time, a number of other measures were taken in order to be well prepared should the pipe be damaged further when the vessel was towed free. Stockholm Vatten kept it operations organisation in on-call preparedness until ASKÖ had been towed free of the ground early in the morning of 12 December 2016.

Stockholm Vatten will need to carry out repairs to both the water pipe and the supporting structure. As these repairs require some extensive underwater work in the form of pile driving, a decision and approval from the county administrative board is required according to Stockholm Vatten before the repairs can begin.

Figure 10. One of the three broken crossbars in the supporting structure. Image: Stockholm Vatten.

Figure 11. The water pipe's bolted flange at a joint and surrounding crush damage in the pipe. Image: Stockholm Vatten.

1.5.4 The marking of the water pipe on charts

According to the Maritime Administration's chart services, the water pipe in question was marked on applicable charts; however, there was no information about the depth of the pipe (approximately 6.5 metres) (see Figure 12). The solid blue lines on the chart along each shore in the fairway represent a depth contour of 10 metres. Accordingly, the chart indicates that the fairway in question has a water depth to the lake-bed of at least ten metres.

Figure 12. Hässelby holme and the marking of the water pipe. Image: The Swedish Maritime Administration's no. 10-01518 chart services.

The water pipe was also marked on older charts (1994). However, there it was stated that the water pipe was at a depth of 6.5 metres (see Figure 13).

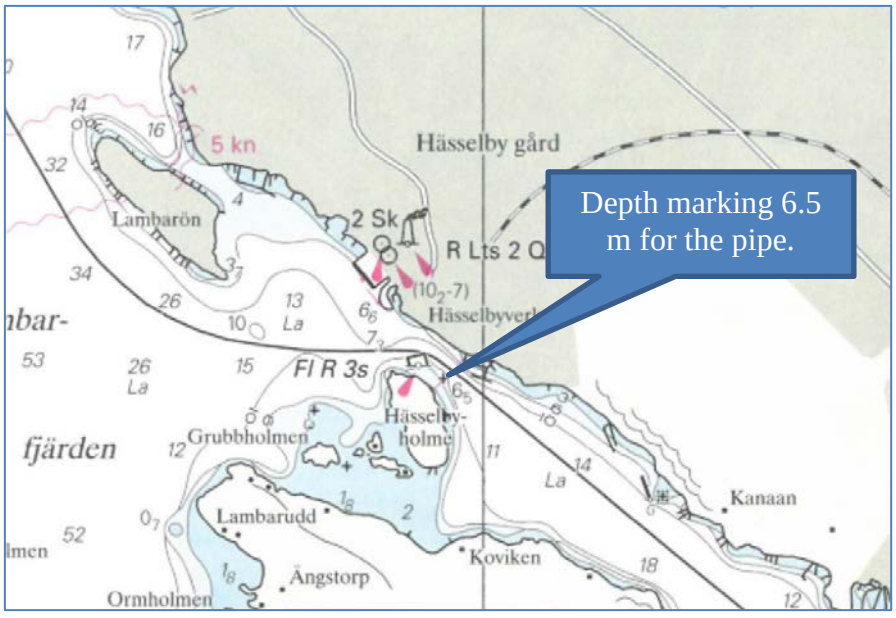

Figure 13. Hässelby holme with marking of the water pipe and a depth indication of 6.5 metres. Image: The Swedish Maritime Administration's chart from 1994. The Swedish Maritime Administration no. 10-01518 chart services.

According to the Maritime Administration, the depth of the water pipe was reported on the chart for this area for the first time in 1954. Following a hydrographic survey in 1988, the chart was given a marking in the form of a submerged rock with a depth indication of 6.5 metres. A further hydrographic survey of the area, commissioned by the Swedish Transport Administration, was conducted in 2012. No water pipe was reported in the data from this survey that was supplied to the Maritime Administration. Consequently, the Maritime Administration chose to remove the depth indication of 6.5 metres, but let the mark of the pipe remain

As a result of ASKÖ's grounding and following dialogue with Stockholm Vatten concerning the deficient marking of the water pipe on the charts in question, the Maritime Administration requested raw data from the hydrographic survey in 2012. At the analysis of the raw material, one could find a trace of the current water pipeline. The Maritime Administration has therefore adjusted the charts with correct depth information for the fairway.

Nautical information was previously published in *Svensk lots*. This is no longer the case. However, Svensk lots 1998 indicates that there was a pipe in the area in question with a free water depth of 6.5 metres. Although this publication is no longer being published, this information is reported on the Maritime Administration's website for each pilotage area. According to the Maritime Administration, all pilots within the area should be aware of this pipe and its depth, despite the charts having lacked depth indication since 2012.

1.5.5 Procedures for updating charts

Information received for updates to the Maritime Administration's chart products is handled in four main stages.

Planning => Collection => Processing (Updating) => Product (Production)

The collection stage involves the Maritime Administration receiving information that might occasion an update to the chart database. This information can come from the authority's own surveying operations, for example via a hydrographic survey, or from external operators in form of chart reports on deviations from the current chart.

All of the Maritime Administration's hydrographic surveys and hydrographic surveys supplied by external parties are to be processed and quality assessed with the goal of storing the information in DIS (the Maritime Administration's depth database).

External clients and hydrographic surveyors are encouraged to make contact with and consult the Maritime Administration prior to conducting hydrographic surveys and the supply of results in order to obtain general advice and information about the Maritime Administration requirements and requests.

Data collection is followed by several quality assurance stages: delivery check, water level check, evaluation, proofing and final checks. All new hydrographic surveys are checked against older hydrographic data and against the applicable chart image. The new hydrographic survey takes precedence over older surveys if it has full bottom coverage.

1.6 Accident site/Place of occurrence

1.6.1 Södertälje Pilotage Area

Södertälje Pilotage Area covers the water area in and immediately outside of the archipelago from Dalarö down to Landsort, on to Sävsundet and then up to Södertälje and Lake Mälaren and Lake Hjälmaren (see Figure 14).

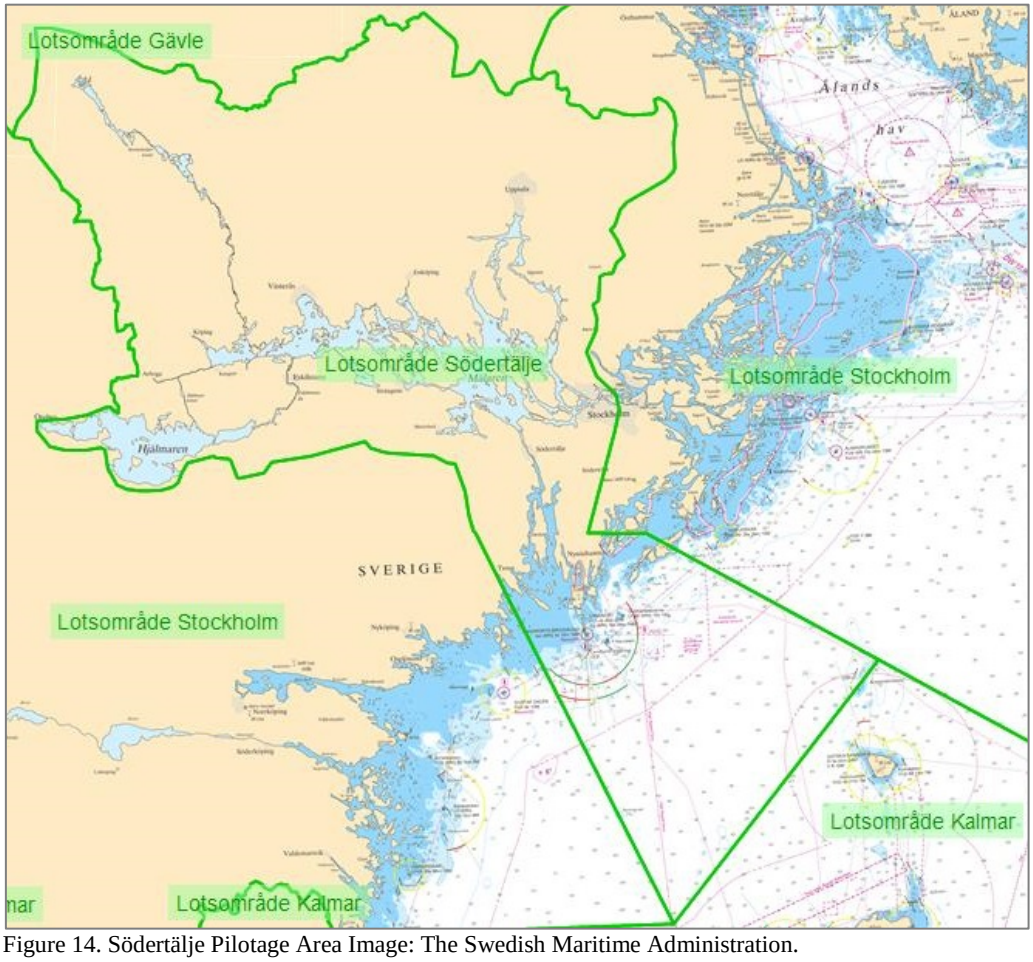

Figure 14. Södertälje Pilotage Area Image: The Swedish Maritime Administration.

The pilotages in Södertälje are some of the longest in Sweden. The voyage Landsort–Södertälje is 34 M, the voyage Södertälje–Hässelby is 24 M, the voyage Södertälje–Köping is 69 M and the voyage Södertälje–Västerås is 62 M.

1.7 Ship particulars

1.7.1 General

ASKÖ was built in 2005 at Hoogezand, the Netherlands. The vessel has one cargo hold with a total cargo capacity of 6,392 m^3. The bridge, engine room and living quarters are all located in the aft part of the vessel. The main engine is a MAK with an output of 1,850 kW.

ASKÖ is equipped with a conventional rudder and the vessel's propulsion consists of one propeller with variable-pitch blades. The propeller is in a nozzle.

Figure 15. ASKÖ. Image: Johannes Kollig.

1.7.2 The bridge

The bridge is constructed with a console that has an Anschütz autopilot (automatic steering), manual steering and an engine room telegraph a little to starboard of the console, all of which are comfortably accessible from the navigator's position and a radar on both the starboard side and the port side of the console (see Figure 16).

Figure 16. The bridge on ASKÖ.

The navigation equipment includes two Sperry Marine radar sets, both of which have ARPA capability[11], GPS[12], DGPS[13] and GMDSS[14] with several VHF stations. There was no electronic chart on board at the time of the accident, neither ECDIS[15] nor ECS[16].

1.7.3 VDR[17] and other technical recorders

The vessel was equipped with a voyage data recorder (VDR), and SHK has obtained data from this. However, the VDR data obtained turned out to be from 11 December 2016 and not from 9 December. Consequently, it has not been possible to use VDR data from the occurrence as evidence in this investigation. According to information from the master, he activated the save function on the VDR on 9 December. SHK has not been able to determine why and by whom the save function had been activated on 11 December.

[11] ARPA (Automatic Radar Plotting Aid) – automatic plotting of the radar echo (calculation of the echo's movements).
[12] GPS (Global Positioning System) – a satellite navigation system.
[13] DGPS – differential GPS is a relative GPS measurement. Differential GPS achieves a greater accuracy than GPS.
[14] GMDSS (Global Maritime Distress and Safety System) – a system for emergency signalling from vessels.
[15] ECDIS (Electronic Chart Display and Information System) – an electronic chart system that can be used as a replacement for paper charts.
[16] ECS (Electronic Charting System) – an electronic chart system that cannot be used as a replacement for paper charts.
[17] VDR – Voyage Data Recorder.

1.7.4 Crew

The crew of ASKÖ consisted of eight people, of whom the master and the chief officer were on the bridge when ASKÖ ran aground. In addition, the bridge was manned by a pilot.

At the time of the occurrence, the master had been a deck officer on various types of vessels since 1981 and since 2002 in the current shipping company. He has been a master since 2004. This was the first time he had called at Hässelby.

At the time of the occurrence, the chief officer had been at sea for 26 years, ten of which as chief officer. He had been employed by the shipping company since 2006. This was also his first time calling at Hässelby.

1.7.5 The pilot who was piloting ASKÖ

The pilot who was piloting ASKÖ at the time of the occurrence had been serving as a pilot in Södertälje since 1997 and prior to this had served as a deck officer on various vessels for ten years.

1.8 Meteorological information

SHK has commissioned SMHI[18] to compile a summary of the weather conditions at Hässelby udde on the night and morning of 9 December 2016. The summary shows that the wind was around west-south-westerly, 3–5 m/s. It was clear to partly clear with a visibility of over 10 M. The air temperature was 5 degrees and the temperature in the water was 1–3 degrees. The significant wave height[19] was < 0.3 metres in the direction of 270 degrees. The currents in the area were almost non-existent over the course of the night and morning (< 0.01 knots).

1.9 Emergency response

Provisions on rescue services are found primarily in the Civil Protection Act (2003:778), LSO, and the Civil Protection Ordinance (2003:789), in the following referred to by use of their acronyms in Swedish. According to LSO, the term “rescue services” denotes the rescue operations for which central government or municipalities shall be responsible in the event of accidents or imminent danger of accidents, in order to prevent and limit injury to persons and damage to property and the environment.

The circumstances relevant to the emergency response are described in section 1.1.4.

[18] SMHI– the Swedish Meteorological and Hydrological Institute.
[19] The wave height is generally given in terms of the significant wave height (SWH), i.e. the mean wave height of the top third of the waves. The highest waves are 1.6 to 1.8 times the SWH. A few isolated waves can reach double the SWH.

1.10 Regulations, inspections and oversight

1.10.1 Watchkeeping

International requirements concerning watchkeeping are found in Chapter VIII of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW)[20] of 1978–cf. the Swedish Transport Agency's regulations [TSFS 2012:67] on watchkeeping.

The STCW states that officers of the watch shall:

- maintain their watch on the bridge, which may under no circumstances be left without them having been duly relieved,
- ensure that careful lookout is always maintained,
- use the chart on board that has the largest scale and is most appropriate for the area. The chart shall be corrected in accordance with up-to-date information. The vessel's position shall be fixed frequently. When the conditions so allow, the position shall be fixed using more than one method.

Independent of the professional duties and obligations a pilot has, the text of the STCW also states that their presence on board never means that the master or the officer of the watch are relieved of their responsibility and obligations with respect to the vessel's safety.

It also states that during the watch, the steered course, position and speed shall be checked at frequent intervals using all available aids to navigation necessary in order to ensure that the vessel is following the intended course.

1.10.2 Voyage planning

The international requirements for voyage planning applicable to this occurrence can be found in Chapter V, Regulation 34 of SOLAS[21]. The requirements in SOLAS regarding voyage planning have been implemented in Sweden through Chapter 2 of the Swedish Transport Agency's regulations and general advice (TSFS 2011:2) on navigational safety and navigational equipment. Chapter 2, Section 1 states that the master shall assure themselves prior to sailing that the voyage has been planned using the relevant nautical charts and nautical publications and that they have taken into account the IMO guidelines and recommendations. The guidelines referred to are primarily IMO Resolution A.893(21) *Guidelines for Voyage Planning*. According to these guidelines, the vessel's route should be plotted on the chart, together with courses, areas of danger and reporting points.

[20] STCW – International Convention on Standards of Training, Certification and Watchkeeping for Seafarers.
[21] SOLAS – International Convention for the Safety of Life at Sea.

1.11 Organisational and management information

1.11.1 Hartmann Reederei

The company was founded in 1981 and now controls around 60 vessels, focusing on three types: gas carriers, bulk carriers and container ships. The company's head office is located in Leer, Germany.

1.11.2 General information about the ISM Code and safety management systems

The International Management Code for the Safe Operation of Ships and for Pollution Prevention (the ISM Code) is a guide for shipping companies' management and operation of their fleets, and aims to promote the development of maritime safety and the prevention of pollution within the shipping industry. As of 1 July 2002, all merchant vessels involved in international traffic that is covered by the IMO's maritime safety convention SOLAS must comply with the code. It is only the smallest of ships that are exempted[22].

The implications of the ISM Code include an obligation for all vessels covered by the code to have a safety management system (SMS), i.e. a structured and documented system that enables the shipping company's personnel to effectively implement the company's safety and environmental protection policy. This system shall include instructions and procedures for ensuring the vessel is operated safely and the environment is protected. It shall also include an action plan for use in the event of emergency situations.

ASKÖ had a valid certificate and documentation of an approved safety management system. SHK has studied selected parts of the shipping company's ISM manual. This includes sections concerning voyage planning, watchkeeping and navigation with a pilot on board. Content from relevant parts of the manual are presented in the following section.

1.11.3 Safety of navigation instructions

Voyage planning

According to the manual, voyage planning is necessary in order to support the bridge crew and to ensure that the vessel can be navigated safety between ports from berth to berth. The voyage plan shall encompass sea, coastal waters and areas where pilotage is compulsory.

The planning process is described as consisting of seven steps: an initial appraisal phase, a phase in which all available and relevant facts are gathered, a planning phase for position fixing intervals, a planning

[22] The code has been implemented within the European Union through Regulation (EC) No 336/2006 of the European Parliament and of the Council on the implementation of the International Safety Management Code within the Community and repealing Council Regulation (EC) No 3051/951.

phase that is based on the assessment that has been made, an execution phase, a tactics and data-collection phase and finally, a monitoring phase.

When it comes to the information-gathering phase, the importance of charts and nautical publications is emphasised. When it comes to the tactics and data-collection phase, the importance of ensuring the vessel's safe movement and navigation is emphasised.

Pre-departure checklist

The manual also contains a checklist with points to check before departure. The question asked in the first point on the checklist is whether the voyage plan has been made from berth to berth. Point two asks whether all charts and publications for the voyage are updated and the course plotted on the charts.

Bridge watch

According to the manual, the officer of the watch is the master's representative on the bridge and therefore has primary responsibility for ensuring the vessel's safe navigation at all times. The vessel's position (fixed using at least two different methods), steered course and speed are to be checked throughout the entire watch by means of the available navigation equipment and is to be checked against charts in order to ensure that the vessel is following the planned course.

Pilot on board

The voyage plan made in advance by the vessel shall be discussed and approved together with the pilot immediately after the pilot has come on board.

According to the manual, the pilot gives orders concerning navigation throughout the entire passage and it is the duty of the master or officer of the watch to cooperate with the pilot in such a way as to ensure that the voyage is conducted in accordance with good seamanship. However, the master and officer of the watch are always responsible for the safe navigation of the vessel. The pilot has only an advisory role.

According to the manual, the time between each fix of position may be a maximum of six minutes when there is a pilot on board. Passage of landmarks and turning points prior to major changes in course must be checked by fixing the vessel's position. The change in course must be checked in the same way once the manoeuvre has been executed. The procedure and the safe passage of critical points in the passage, for example areas of uncertain depth under the keel (UKC)[23] and passage close to shallows or landmarks, must be double checked against the voyage plan.

[23] UKC – under-keel clearance.

Charts and publications

According to the manual, the master must also ensure that up-to-date charts and publications pertaining to the type of vessel and the areas it will traverse are on board. It is stressed that the vessel's seaworthiness is not confirmed by the certificate alone, but also by the presence of the correct charts, publication and other handbooks on board.

Emergency preparedness

The vessel's ISM manual specifies the actions that are to be taken in the event of a grounding. It first states immediate actions concerning checking for damage to the vessel and injuries to the crew and actions to secure the VDR recording. Once the immediate actions have been completed, the shipping company and classification society are to be contacted. The checklist also stipulates that the coastal state is to be contacted.

1.12 The relevant aspects of the Swedish Maritime Administration's operations

Working hours and working hours agreements for pilots

The working hours of pilots in Södertälje are regulated in an agreement between the Swedish Maritime Administration and the Swedish Pilots' Association that was entered into in 1999.

A period on duty, i.e. the number of days a pilot is available for work, may encompass a maximum of seven and a minimum of three days.

At least nine hours of a 24-hour period shall be a rest period (Section 9). The rest period shall be undisturbed, but can be split up. The agreement does not state how long the split rest periods must be. However, according to consistent information from the interviews, the rest may only be split once and every part is to be at least four hours, i.e. if a rest period is split and the pilot gets a four-hour rest, the next rest period shall be at least five hours.

The pilot shall be at the disposal of their employer for the remaining part of the 24-hour duty period. However, the time allowed for reporting for duty shall be adapted to local circumstances and the time of day. Nonetheless, the time allowed for reporting for duty may not be more than one and a half hours. The standard method is to allocate two hours for travel during a 24-hour duty period.

Order of precedence instructions

As a complement to other agreements, an order of precedence instruction for how pilots' available time is to be organised has been signed for the area Lake Mälaren–Landsort.

This instruction describes how the order for assignments is determined. Once a pilot has had an undisturbed rest period of nine hours, they move to first place in the order for a new pilotage assignment. The pilotage planning service and the pilot share the responsibility for ensuring that the pilot obtains nine hours' undisturbed rest.

The instruction states that pilotage assignments or series of assignments that are planned to take more than eight hours and will be undertaken entirely or partly at night (00:00–05:00) are to be assigned to two pilots. At other times of the day, the maximum planned length of an assignment or a series of assignments is nine hours. A series of assignments ceases to be a series when an undisturbed rest period is taken. This also applies in the event of a split rest period.

1.12.2 Interviews with personnel from Södertälje Pilotage Area

Interviews have been conducted with pilots and the pilotage service's management, control and planning personnel in Södertälje Pilotage Area.

Södertälje Pilotage Area command and control

Personnel from Södertälje Pilotage Area management and control were primarily asked questions concerning working hours and scheduling, which revealed the following.

There are always about ten pilots serving who work a continuing and comprehensive eleven-week schedule. Normally, pilots come on duty at 06:00 on the first day of their duty period. The majority of pilots work on a schedule of seven consecutive days on duty, followed by the same number of rest days. Some pilots have instead chosen to work three four or five days in a row, followed by as many days' rest. The main reason for this has been that the pilots find working seven days in a row to be strenuous.

The majority of assignments the pilots are given involve working at night. The agreement defines night work as work between midnight and 05:00.

According to the agreement, the pilots have the right to nine hours undisturbed rest. In some cases, this rest period is split. The pilot must be asked whether a split rest period is acceptable. The pilot is not required to accept this, rather they have to say no if they, for example, are too tired. It is the management and control personnel's perception that the pilots are generally good at speaking their mind, but that they rarely refuse to accept a split rest period. If a pilot says no, the question then passes to the next person. Split rest periods, occur two to three times a month and pilot each month.

The pilotage planning service

The questions asked to the pilotage planning personnel primarily concerned working hours, planning and scheduling, revealing the following.

The pilotage planning service generally adheres to the order instructions and complies with the agreement terms and conditions that cover the pilots' working hours. The implications of this include that the pilots may not be disturbed during their nine-hour rest period, that they must be asked whether they accept a split rest period and that their working hours may not exceed eight hours at night and nine hours at other times.

In general, the planning process involves attempting to put together a schedule that is as efficient as possible. How this is done in purely practical terms differs somewhat between different individuals. Some maintain close contact with the pilots by telephone, while others manage these matters to a greater extent electronically via the special app, known as the Pilot app, that pilots have on their phones.

Pilots

In order to investigate and be able to describe the pilots' work environment in Södertälje Pilotage Area, interviews have been conducted with a number of pilots who work there. The pilots have been asked to describe how they perceive the physical and psychosocial work environment and how working hours, scheduling, night work, etc. function. The following has been raised.

Working as a pilot involves primarily working in the evening, at night and in the early morning. One estimate is that around 75 per cent of the work is performed at these times of day. The planning of this work takes place by means of a central planning service that the pilots for the most part feel functions satisfactorily. However, some problems with the scheduling have been raised. For example, the time taken to travel from one location to another has been underestimated.

Vessels have to make preliminary reservations for their pilotage requirements and this has to then be confirmed no later than five hours prior to the beginning of the assignment. In the light of this sometimes relatively short planning horizon, it may be difficult to plan in rest periods in a constructive manner. Even though the length of the shift is not always so long, it is difficult to know in advance when there will be an opportunity to sleep.

Because the work can take place at any time of the day or night, it is rarely the case that the rest period, and thus the opportunity to sleep, occurs at the same time each day. This means it can be difficult to sleep when there is actually time for it, which in the long term results in it being difficult to sleep and to recover as is needed. In order to compensate for this variation, the pilots themselves attempt as far as is

possible to obtain information about forthcoming pilotages in order to gain an understanding of when the next pilotage is coming. The pilots emphasise the importance of the planning service having as good forward planning as possible so that it becomes easier for the pilots to know when they will be working next, making it easier to plan their rest.

Split rest periods are not common, but they do occur. A pilot must always be asked whether they accept a split rest period and it is always possible for them to say no. However, it is very uncommon that you do not accept a split rest period, primarily due to the perceived peer pressure from colleagues. Because they work to a schedule that involves an order, they do not want to burden the next person in the order by saying no. That's why in practice, no one ever does.

It appears that for the past several years, the planning service has, in principle, departed from the procedure of asking the pilots whether they accept a split rest period prior to it being planned in. For assignments that begin in Södertälje Lock and onward out to Landsort, a split rest period is in some cases scheduled to allow a pilot to take one vessel out and another back in. According to the pilots interviewed by SHK, they are not generally asked in advance whether they accept a split rest period.

During the pilotages, they do not have any opportunity to take a break. They need to be on the bridge, piloting the vessel through the fairway. This also means that they have limited opportunities to eat and drink on board.

The majority of pilotages in Södertälje Pilotage Area take six or more hours. The length of the various pilotage assignments varies depending on the destination in Lake Mälaren. The longest pilotages (to destinations in western Lake Mälaren) take more than nine hours. In winter, the pilotages can also be significantly longer due to the ice situation.

The perception of what a long or too long pilotage is varies from pilot to pilot. Some state that piloting for six hours without the opportunity for a break works fine in some cases, for example during the day. However, longer pilotages of close to six hours at night are more strenuous. The pilots highlight the opportunity to make some longer pilotages shorter in order to reduce this strain by changing pilots in Södertälje Lock. Instead of one pilot taking the entire pilotage, for example between Landsort and Hässelby, a change of pilot can be scheduled for the lock.

Being a pilot involves piloting many different vessels and crews; no two vessels are exactly alike. The equipment that they have to work with can vary. Pilots must be able to quickly familiarise themselves with the equipment if they are to accomplish their assignment. Some vessels that are to be piloted through Lake Mälaren may lack im-

portant equipment, for example charts. The pilots have their own personal laptop that allows them to call up an electronic chart. However, if a vessel does not have her own charts, there is an impact on the ability of the crew to contribute and keep track of the vessel's navigation.

1.12.3 Advance information to pilots about deficiencies on board vessels

MSW (Maritime Single Window) is a portal for reporting information connected to vessel arrival and departure from ports to public authorities. The functions in this portal include the opportunity to order a pilot. There is currently no specific field or equivalent in MSW for reporting faults or deficiencies in conjunction with ordering a pilot. However, the customer does have the opportunity to fill in a free-text field entitled "Message from customer". This is a one-way communication that the pilotage planning service cannot reply to. This information does however accompany the pilotage order and is presented to the pilot in the Pilot app.

In addition to the information from the customer, there are two types of information that the pilotage planning service can enter into the system. The first is a "Swedish Maritime Administration Note", which is specific to the individual pilotage assignment, and the second is a "Vessel Note". The vessel note applies to the vessel and remains in place until someone actively removes it. Examples of vessel notes are "aft thruster does not work", "weak stern thruster", "bow thruster 250 hp" etc. In both cases, the information is presented to the pilot via the Pilot app.

SHK has recently investigated an accident that brought to the fore the issue of reporting faults and deficiencies in conjunction with the ordering of pilotage (cf. SHK's report RS 2016:01 BONDEN/ASIAN BREEZE). In the final report, the Swedish Maritime Administration was recommended to develop systems and procedures which enable pilots to obtain all necessary and relevant information in good time prior to pilotage, including any faults and deficiencies on the ship in question (recommendation *RS 2016:01 R4*).

The Maritime Administration's response to this recommendation contained the following statement:

> *In light of this, the administration will take the first step and investigate the technical possibilities of bringing about a technical solution for voluntary reporting of known faults and shortcomings on ships in connection with ordering a pilot. This voluntary reporting can also be combined with the provision of information to the brokers and shipping companies that order pilots. It is the administration's goal to investigate the potential for voluntary reporting in autumn 2016. The administration also intends to update and clarify existing routines for the exchange of information between pilot and pilot services providers in order to provide further assurance that the pilot will receive all necessary and relevant details prior to pilotage, including faults and shortcomings in the ship in question. The intention is for the update to be complete in autumn 2016.*

The instructions concerning information exchange between the pilot services providers and pilots was updated on 26 June 2016. These instructions state that while preparing the pilotage order and when the pilot is appointed for the assignment, the pilot services provider shall provide the pilot with information that forms the basis of the pilot's planning, including information concerning known deficiencies in the vessel's manoeuvring or navigation equipment. This part of the recommendation thus appears to have been implemented. Nevertheless, to the best of our knowledge, the Maritime Administration has not yet introduced any technical solution for reporting faults and deficiencies on vessels in conjunction with ordering pilotage.

The Maritime Administration does not have procedures or other aids pilots can use to assess whether or not a vessel is seaworthy, and thus whether it is to obtain the services of a pilot.

1.13 Work environment factors

1.13.1 General information about pilotage

The pilot must constantly take into account the actual local conditions and circumstances in order to navigate a vessel. The pilot needs to have control of instrumentation used to, for example, monitor rudder angle indicators, rate of turn, speed and, when necessary, adjusting the rudder in order to maintain the correct course and handle VHF communications. If the pilot steers the vessel themselves, they must also undertake course corrections.

The pilot's need to use charts and radar varies depending on how the fairway looks. The pilot may need to switch between automatic steering and manual steering in different passages in a fairway. The pilot will probably use manual steering in areas that are difficult to navigate. The navigation task also involves the pilot continually checking that the vessel is not getting too far out in the fairway, i.e. that the vessel is where she should be.

The job of a pilot is thus a varied one and one that requires various degrees of attentiveness, depending on the circumstances. In areas that are difficult to navigate, the pilot's job becomes more strenuous and requires greater mental resources, for example for planning the onward voyage, handling instrumentation and checking the vessel's position. During simpler passages, the pilot's job is less demanding. The work then becomes more focused on supervision, i.e. monitoring and checking the vessel's progress.

1.13.2 General information about fatigue and night work

The normal human circadian rhythm means that we sleep during the night and are awake during the day. While the sleep requirement certainly varies between different individuals, the majority require between seven and nine hours' sleep. Fewer than seven consecutive hours of sleep equates to a varying degree of sleep deficit. Fewer than five hours equates to a critical sleep deficit.

There are two principal physiological processes that affect how alert or tired a person is. One is the circadian rhythm, i.e. the body's natural rhythm for regulating physiological changes at different times of the day, the other is the relationship between how much and when we sleep or are awake.

The body is therefore predisposed to sleeping at night and being awake during the day. People are most tired at night, normally sometime between 02:00 and 05:00. If a person who normally sleeps at this time instead is awake, they will be very tired.

However, people can adapt to being awake at night and have their main period of sleep during the day. This is regulated by the second of the two processes mentioned above, i.e. the relationship between when and how much we sleep and are awake. By altering when the main period of sleep takes place, it is possible to adjust the body's circadian rhythm by about one to two hours per day. The body is thus able to adapt to sleeping and being awake at times other than those that are normal. If given sufficient time to adapt, the body is therefore able to cope with, for example, shift work, without this having a decisive impact on alertness. Provided that the conditions allow undisturbed sleep, the main period of sleep, combined with other rest can be sufficient to avoid exhaustion or sleep deficit.

Night work, especially shift work, is still associated with certain risks. Even if a person is able to adapt to working at night, the circadian rhythm means, in spite of their adaptation, that there are critical times at which they are more tired than normal, for example during the aforementioned period between 02:00 and 05:00 at night.

There is a direct relation between the time of the day at which the main period of sleep begins and how long it lasts. In general, the period of sleep is reduced if it begins after midnight and before 18:00 in the evening. This is associated with the fact that we want to wake up when it is light.

Another factor that has an impact on the degree of fatigue is how long a person has been awake. A continuous period awake that is longer than 18 hours carries a high risk of reduced alertness.

The perceived level of fatigue is also largely dependent on what type of task a person is performing. Work that is monotonous and "passive" monitoring tasks lead to a higher level of perceived fatigue,

while a task that involves a high degree of active participation leads instead to a lower level of perceived fatigue.

1.14 The pilot's schedule and time on duty

The pilot works on a schedule that involves him being scheduled to be on duty 24 hours per day for a short period (three to seven days), followed by a corresponding rest period completely without work.

In this case, the pilot had been on duty from 08:00 on the morning of 6 December. It was during the third night of the duty period that the grounding took place. He had had pilotages on each of the three nights he had been on duty. These pilotages had begun just after midnight on the first two nights and had continued until 08:00 on 7 December and until 05:00 on 8 December, respectively. Then on 8 December, the pilotage began again at 22:30 and was to be completed at around 05:00 on the morning of 9 December.

His sleep had been split up during the rest periods. On the day before the grounding, the pilot had slept for 6.5 hours, split into two periods of 4.5 and 2 hours (between 06:00 and 10:30 and between 18:00 and 20:00). Given the everyday situation at home, it was difficult to get more than 4–5 hours' undisturbed sleep in the morning. Consequently, the pilot usually ensured that he also got some sleep in the evening, which was also the case on the day in question.

Figure 17. The pilot's work schedule. The pilotages have been marked in red. Green indicates rest/sleep, with the darker green showing when the pilot was asleep. Blue denotes travel time to and from the workplace.

The pilot has himself stated that he did not feel particularly tired during the shift in question. He even felt wide awake when he went on board ASKÖ. However, he became more fatigued as the pilotage progressed.

The master's and chief officer's schedule and time on duty

The master had the so-called 8–12 watch[24] and had had at least thirteen hours' rest over the course of the 24-hour period prior to the grounding. The latest rest period fell between 14:00 and 20:00 on the day prior to the grounding. The master was up on the bridge in conjunction with the passage of Södertälje Lock, which does, however, not correspond to the record of his work and rest periods.

[24] the 8–12 watch involves having the bridge watch from 08:00 to 12:00 and from 20:00 to 24:00.

The chief officer, who had the watch at the time of the grounding, had begun his shift at 04:00. Immediately prior to this, the chief officer had had a continuous rest period of 8 hours.

1.14.2 Human error

There are several different ways to categorise human error. One system that is often used is the generic error-modelling system[25]. In this system, actions are roughly divided up into two categories. The first category is made up of actions that are performed as intended, yet still lead to an undesirable result (intended actions). The second is made up partly of actions that are not performed as intended and partly of failures to act (unintended actions).

The latter category can also be divided further into two sub-categories called “slips” and “lapses”. Such errors are often associated with control and operations environments that are not well designed or with factors related to the individual, for example reduced capacity due to fatigue. The term lapse denotes in particular those actions that are not performed because one step of a procedure is forgotten.

1.15 Tests and research

Not applicable.

[25] Reason, James (1990). *Human Error*. Cambridge University Press.

2. ACTIONS TAKEN

2.1 Hartmann Reederei

The shipping company has sent out a document (transfer of knowledge) to all its vessels describing the accident and the lessons that can be learned from it. This specifically mentions that all watch-keeping personnel on the bridge are to study the document and that an extra safety meeting is to be held as a result of the grounding of ASKÖ.

2.2 The Swedish Maritime Administration

In order to clarify that the depth of the current location at the water-pipe is less than 10 meters, the Maritime Administration has adjusted the chart by adjusting the depth curves to a depth of 6 to 10 meters (see Figure 18). In addition, the Swedish Maritime Administration has updated valid procedures with additional checks and identification of objects for incoming externally hydrographic surveys. At the Maritime Administration's own hydrographic surveys it is already a routine to always carry out the identification of objects as described in the chart. In addition, the Swedish Maritime Administration has been given the task of Stockholm Vatten and Avlopp to thoroughly hydro-graphic survey this and all other water pipelines with the same con-struction in their possession. This will ensure correct depth in the Swedish Maritime Administration's databases and products.

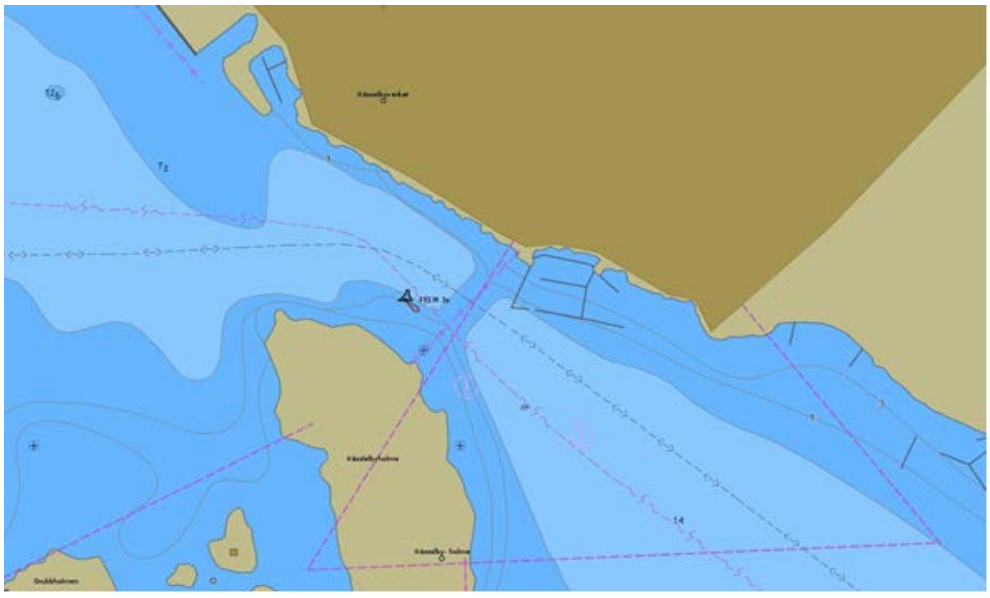

Figure 18. New chart image. Image: The Swedish Maritime Administration.

3. ANALYSIS

3.1 Fundamental aspects of the course of events

3.1.1 What happened prior to the grounding?

Course of events

The pilotage of ASKÖ started at 22:30 on the evening of 8 December 2016. The pilot was alone in looking after the navigation on board throughout the entire voyage. The voyage between Landsort and Hässelby takes about six and a half hours. The officers of the watch in the crew were on the bridge during the voyage, but were not directly involved in the actual navigation or driving of the vessel. As stated, there was no chart on board for the voyage through Lake Mälaren i.e. after Södertälje. Nor was there any electronic chart as an aid to navigation. The pilot had brought his own computer with him on which the charts in question were accessible. Consequently, it was only this computer that was used to navigate the vessel.

At around 04:30, ASKÖ passed Nockeby Bridge. At that time, the pilot was on the bridge, together with the master and the chief officer. The pilot navigated the vessel from Nockeby Bridge. Navigation on this part of the voyage is simpler as few course corrections are required.

According to all those present, it was largely quiet on the bridge, with the exception of some brief verbal communication between the pilot and the crew, mainly concerning the actual arrival at Hässelby CHP Plant. No information about navigation was exchanged between those on the bridge.

Quite soon after Nockeby Bridge, the pilot sighted the red buoy (see Figure 2), at Hässelby holme. The pilot's plan was to use the buoy as a steering mark in order to, when they were getting close to it, make a small course correction to starboard and then turn to port after passing the buoy, before finally turning to starboard round and in to the quay.

The pilot chose to switch over from automatic steering to manual steering approximately 1 M from the buoy, still without the bridge crew aiding the navigation. The course steered by the pilot was 309°. The fairway and the prevailing weather conditions meant that it was possible to maintain this course without any major corrections. The task of piloting the vessel had been more demanding earlier in the voyage, with major course corrections and handling of the vessel. However, the final part of the voyage up to the buoy was less demanding and the pilot mainly needed to simply monitor the vessel's progress.

As the pilot described it, he suddenly discovered that the vessel was on the wrong side of the buoy. He then stopped the engine, but was unable to prevent the vessel from running aground.

Bridge cooperation

The investigation indicates that the bridge cooperation on board was very limited. The crew neither joined in with the navigation nor realised prior to the pilot detecting this that the vessel was on the wrong side of the buoy. The master had requested the applicable charts for Lake Mälaren when the vessel called at a port in Finland prior to her arrival in Russia. However, the charts were not available. Consequently, the crew had no charts on board for the voyage through Lake Mälaren, which had in turn resulted in them not having a voyage plan. The fact that the crew lacked charts probably contributed to their inactivity and lack of contribution to the navigation of the vessel.

It is of course not recommendable to undertake the voyage without charts. The fact that the voyage was still undertaken in this way means that the vessel was not to be considered seaworthy in accordance with either the Swedish Maritime Code or the shipping company's own ISM manual. To handing over all of the responsibility for navigation to the pilot can not to be considered appropriate.

All in all, these factors, combined with the shortcomings in bridge cooperation, may be considered to be a contributing factor to the vessel's running aground.

The shipping company's own investigation of the occurrence has identified these shortcomings and has referred to the fact that its ISM manual clearly describes how a situation such as the one in question is to be managed. Information about the accident and the lessons that can be learned from it have also been conveyed to all watchkeeping personnel. In the light of this, SHK refrains from issuing any safety recommendations to the shipping company relating to the bridge cooperation.

3.1.2 The grounding

The pilot has subsequently not been able to explain how and why the vessel ended up on the wrong side of the buoy. However, he has stated that he was surprised when he actually discovered where the vessel was.

An occurrence of this type is described in the literature as a "slip" (see section 1.13.2) and is often caused by either fatigue or distraction.

The investigation has shown that the risk of distraction was small at the time of the grounding. On the contrary, the environment on board was calm and quiet as there was limited communication between the people on the bridge, at the same time as the work situation had a low

intensity. Thus the conditions were rather of the type that may have reinforced any fatigue on the part of the pilot.

However, the pilot has stated that he did not feel tired at the time in question. This does not, however, prevent his vigilance from having been impaired by factors associated with, for example, sleep and rest.

At the time of the grounding, the pilotage had lasted for approximately six and a half hours. In the academic literature, the existence of a tedium and fatigue problem associated with performing one single task for a long period (known as “time-on-task”) has been described in several contexts. Performing the same task for 3–4 hours or more has been found to be associated with certain risks. The risk varies depending on the type of task and its complexity, as well as other conditions such as the time of day, opportunities for breaks and rest, food intake and external conditions, for example the weather and wind. A complex task can become far too strenuous to perform over a long period. On the other hand, performing a simple and low-intensity task can result in rapidly impaired performance because it becomes more difficult to maintain concentration and vigilance.

The investigation shows that the occurrence occurred following a low-intensity work situation at the end of a long shift that had contained few opportunities for breaks and food intake. On top of this, the time in question, around 05:00 in the morning, is a circadian low point, i.e. a time of the day at which people are typically more fatigued than otherwise and the body is normally disposed to being asleep.

On this occasion, the pilot had been working at night for three days. During this period, he had slept at times of day that at least partly v aried from day to day. In addition, the time he slept had been split up on all of the working days and had never amounted to more than six consecutive hours of sleep on each occasion. It is therefore possible to assume that he had only developed some habituation to night work, but had not adapted to it.

As described previously, sleep lasting fewer than five consecutive hours equates to critical sleep deficit for the majority of people. On the day prior to the grounding, the pilot slept for about 6.5 hours, split up into 4.5 hours in the morning and 2 hours in the evening. On the previous day, he had slept for 8 hours, but this was split up into two occasions of 3.5 and 4.5 hours, respectively, with 4 hours awake in between. There are therefore grounds to assume that the pilot was suffering from a built-up sleep deficit at the time of the grounding.

Given the circumstances reported here, SHK makes the assessment that it is probable that a built-up sleep deficit, the time of day, the long pilotage and the lack of opportunities for rest and recovery have in combination led to the pilot’s degree of vigilance having been impacted negatively by fatigue at the time of the grounding, and that this

may have contributed to the pilot not detecting that the vessel was on the wrong side of the buoy in time.

3.2 The shipping company's management of the occurrence

Navigating a vessel places great demands on the responsible officer to continually check where the vessel actually is and at the same time constantly plan the onward voyage. It is in the light of this that both the STCW and the vessel's own guidelines state that the officer of the watch's responsibility for their duties does not cease even if a pilot is engaged.

The rules and procedures laid down by the shipping company clearly state that the maintenance of an adequate bridge watch shall be a pro-active effort. They also clearly state that the master is responsible for ensuring that all the charts and publications relevant to the voyage are on board. Nevertheless, the master chose to continue the voyage after Södertälje, on the ground that the pilot had his own charts. But that pilots have their own charts and their own route planning do not diminish the masters obligations.

It is SHK's opinion that the accident that occurred gives the shipping company grounds to go through its safety management system with its masters in order to ensure that they understand the importance of working proactively with respect to navigation and that the relevant charts and publications are on board. The shipping company must also ensure that officers of the watch have good knowledge of their duties during pilotage.

The shipping company has reported that, following the occurrence, it has taken such action. In the light of this, SHK refrains from issuing any safety recommendations relating to this.

3.3 What is the pilots' work environment like?

3.3.1 Working on board

A pilot rarely knows prior to boarding a vessel what the status of the equipment on board is. Consequently, their first task on board is to check the equipment in order to make sure it's possible to conduct the pilotage.

In this case, no technical deficiencies related to the vessel's engine or steering had been reported. However, the investigation has shown that the vessel lacked applicable charts for the voyage after Södertälje and that those on board had not made a voyage plan for the voyage through Lake Mälaren. The pilot was therefore dependent on using his own computer with the applicable electronic charts and thus became, in practice, solely responsible for driving the vessel.

The lack of charts and a voyage plan meant that the vessel cannot be considered to have been seaworthy. These conditions also led to an

excessively high workload for the pilot. Thus, the prerequisites for conducting a safe pilotage were poor even before it began. The pilot chose to continue the voyage due to the fact that he had his own charts in his computer that he could use for navigation.

During the investigation, several pilots have described how they in the past used to have a checklist that they would take out to the vessel as an aid for checking whether the vessel was seaworthy and whether it was possible to conduct the pilotage. Reportedly, the checklist is no longer used. Without clear organisational support, it can be difficult for an individual pilot to decide themselves that a pilotage is not to be conducted. As a result, it is SHK's opinion that the Maritime Administration should consider reintroducing some form of aid of this kind.

3.3.2 Planning of working hours

As already mentioned, there are risks involved in working during the circadian low point of the day. One of these is not obtaining sufficient recovery during the rest period because, as in the case of the pilots, sleep takes place at completely different times than normal. The prerequisites for being able to obtain a satisfactory rest are further impaired by the fact that the pilots often do not know when their next rest period will be. A risk factor that reinforces this is if the hours of sleep, as was the case here, are constantly being moved forwards or backwards. This quickly leads to a sleep deficit building up.

In the event of night work, where the hours of sleep are not regular, it is therefore important to draw up a schedule that, to the greatest possible extent, involves the movements in the hours of sleep being as small as possible. One way for employers to prevent fatigue is to draw up a fatigue management plan in which the schedule is analysed in order to identify risks. Over the course of the investigation, it has emerged that the Maritime Administration does not have such a plan.

There are also examples from other pilotage areas where the employer has chosen not to assign personnel who are on duty for more than three days a pilotage assignment on their third night on duty in order to provide them with greater opportunity to recover.

3.3.3 Longer pilotages

As indicated above, longer pilotages such as those between Landsort and Hässelby are associated with many challenges. Admittedly, the perception of what constitutes a long pilotage differs between the pilots interviewed. The circumstances in this case are also of major significance to how strenuous a long pilotage is. The complexity of the pilotage is one other significant factor. Some assignments are simpler, despite being longer. The research supports the appropriateness of doing as much as possible to prevent an assignment becoming too long so that the pilots are given the opportunity to rest and recover.

There is no universal measure to indicate when someone has worked too long. For example, performance can deteriorate very quickly, i.e. within a single hour, when performing very low-intensity tasks (simple monitoring tasks). When performing more variable tasks, stamina may be greater and the risk of impaired performance decreases. In the light of this, the pilotage assignments should be judged on the basis of a comprehensive assessment. These conditions need to be analysed together with those who carry out the assignments in order to reveal the conditions under which an optimal level of performance can be maintained. A good benchmark is that someone should not work more than three to four hours without an opportunity to take a short break or rest.

The pilots interviewed by SHK appear to agree that on this and similar pilotages it is appropriate to change pilots in Södertälje Lock. In a case such as this, doing so would mean that one pilotage of six hours would instead be two pilotages of about three hours each.

The research supports the notion that limiting the scope of an individual assignment in this way can reduce the risks. In the light of this, SHK believes that the Maritime Administration should be recommended to review its methods for scheduling in order to, if possible, shorten the pilotages that exceed 3–4 hours. The Maritime Administration should also comprehensively evaluate whether it is possible to strengthen the foresight of its planning in order to make it possible for pilots to obtain a more regular continuous rest even during their days on duty.

3.3.4 Recovery

There is actually no opportunity to take a break during a pilotage assignment. Even short breaks for calls of nature must be planned in and adapted to the circumstances of the pilotage assignment. However, a short break from the task has a positive impact on vigilance and performance and reduces the risk of fatigue, at least for a while.

A satisfactory intake of nutrition and energy is also important to maintaining the ability to concentrate. In most cases, there is the opportunity to at least eat or have tea or coffee on the bridge while piloting. However, several pilots have pointed out that it is difficult to plan for proper meals because they rarely know what they can expect on board a vessel. This becomes most tangible during longer pilotage assignments.

Also on the basis of these aspects, it would thus be positive from a safety perspective if it was possible to reduce the length of the longer pilotage assignments.

3.4 Information about the vessel's status prior to pilotage

SHK deems it serious that a vessel that lacks charts and is therefore not seaworthy enters Lake Mälaren. In this case, there are grounds to point out that charts could have been delivered to the vessel on its arrival at Södertälje.

Neither the lack of charts nor the lack of a voyage plan on board was reported prior to the vessel's arrival at the pilot station. It is important that this takes place in order to provide the opportunity to plan the actions that must be taken in order to take a vessel into a quay.

As mentioned, the portal for reporting information connected to vessel arrival and departure from ports to public authorities, the Maritime Single Window (MSW), contains no specific field or equivalent where the vessel or their agents can report deficiencies in conjunction with ordering a pilot (see section 1.12.2). SHK has previously recommended that the Maritime Administration work to ensure there is a technical solution introduced in MSW for voluntary reporting of such deficiencies on board. According to information from the Maritime Administration, this requirement has been reported to those responsible for MSW. However, no such solution is yet in place. SHK therefore has to stress once again that such a technical opportunity would increase the likelihood that pilots are made aware of faults and deficiencies prior to a vessel arriving at the pilot station.

3.5 Possible improvements to bridge equipment

ASKÖ did not have electronic charts on board. A digital chart provides greater opportunity to quickly gain a visual overview of the vessel's position in relation to its surroundings. While it is true that there are no requirements to have such charts installed, SHK is of the opinion that it is appropriate for the company to invest in such equipment to increase safety.

3.6 The water pipe and its marking on charts

3.6.1 Stockholm Vatten's handling of the damage to the water pipe

The water pipe that ASKÖ ran over is one of Stockholm Vatten's main pipelines from Lovö Waterworks. The water pipe is of vital importance to the water supply of a large part of the Stockholm area. It stretches from the shoreline along the bottom down to a depth to the upper edge of the pipe of approximately 6.5 metres. The pipe rests there on a wooden supporting structure. This means that the pipe is in a vulnerable position.

Stockholm Vatten acted quickly when it learned of ASKÖ's grounding and position. The company's crisis management and on-call organisation were activated even before they had received confirmation that the vessel had hit the water pipe. For preventive purposes, the crisis management also made a quick decision to take the pipe out of

operation. Stockholm Vatten acted in accordance with its crisis and preparedness procedures and was able to reroute its production to other feeder pipes relatively rapidly. Consequently, the grounding resulted in no major disruptions to the water supply.

Once Stockholm Vatten had conducted its own dive inspections, it was possible to establish that the pipe itself was intact, but that the pipe's insulation and parts of its supporting structure had been damaged and needed to be repaired. The assessment from Stockholm Vatten was that it was pure luck that the water pipe was not damaged more extensively, which could have resulted in major consequences for the water supply in large parts of the capital city area.

3.6.2 The water pipe and its marking on charts

The water pipe's origin dates back to the 1950s. It can be established that the pipe is placed in a very vulnerable position if a vessel, as was the case with ASKÖ, ends up outside the fairway and runs up towards the shore. It can happen that a vessel runs aground outside of the fairway markings, as a result of navigation errors, technical faults on board or the fairway marking being missing or having ended up in the wrong position. Accordingly, it is of great importance that the planning of pipes, cables and other equipment that is to be located underwater, on or above the sea or lake-bed, in areas where large commercial shipping operates also takes into account the fact that accidents involving vessels can occur and that equipment may therefore be hit by shipping and damaged if it is located in a vulnerable position.

The course of the water pipe in the fairway has from the beginning been marked on charts. As the pipe does not lie directly on the lake-bed, there has also been a depth indication on the charts since 1988 in the form of a submerged rock with a free depth of 6.5 metres.

A hydrographic survey of the area was conducted in 2012, the data from which was studied by the Maritime Administration. However, according to the Maritime Administration, there was no water pipe reported in this data. Consequently, the Maritime Administration chose to remove the depth indication of 6.5 metres. Nonetheless, it did leave the marking of the pipe's course in place.

However, Stockholm Vatten reports that it made attempts to point out to the Maritime Administration that the depth indication was missing from the charts in question. However, the company has said that it was referred to the company that conducted the hydrographic survey in 2012.

SHK concludes that the Maritime Administration's procedure for updating charts and reviewing data was not able to prevent the depth information being removed without this being checked against previous versions of charts or with the owner of the installation in question. Even though the Maritime Administration's pilots have been aware of

the depth at which the water pipe lay, it is important that other actors who are on the lake can rely on the depth information shown on applicable charts. The Maritime Administration has currently updated current routines. with additional controls and identification. Against this background, the accident commission refrains from submitting any safety recommendations to the Maritime Administration regarding these deficiencies.

4. CONCLUSIONS

4.1 Findings

a) The vessel lacked charts for the voyage Södertälje–Hässelby, which meant that the vessel was not seaworthy according to applicable regulations and the shipping company's ISM.
b) There was no voyage plan for the voyage Södertälje–Hässelby.
c) The depth of the water pipe was not marked on applicable charts.
d) Damage occurred to the water pipe's supports and insulation, but no holes were made in the pipe.
e) The bridge cooperation prior to the grounding was limited, with very little communication.
f) The vessel's crew did not contribute to the navigation of the vessel.
g) The pilot was on his third day on duty, and night work had occurred on all of these.
h) The pilots' daily rest periods can be placed at any time of the day.
i) Split rest periods are accepted to a very great extent by the pilots in Södertälje Pilotage Area.
j) There are very limited opportunities for rest and recovery during an ongoing pilotage assignment.

4.2 Causes

The cause of the accident was shortcomings in the monitoring of navigation.

Other factors that have contributed to the occurrence:

- The lack of satisfactory bridge cooperation between the pilot and the crew.
- No voyage plan had been made by the vessel's crew for the final part of the voyage.
- The vessel lacked charts for the final part of the voyage.

Against a background of a built-up sleep deficit, the time of day, the long pilotage and the lack of opportunities for rest and recovery, it is

probable that the pilot's level of alertness has been adversely affected by fatigue at the time of the grounding. This has led to insufficient vigilance, which in turn may have contributed to the fact that the pilot did not discover in time that the vessel was on the wrong side of the buoy.

One important underlying factor is the pilots' irregular working hours and rest periods, which make it difficult in planning for rest and thus also to obtaining a proper period of continuous sleep.

5. SAFETY RECOMMENDATIONS

The Swedish Maritime Administration is recommended to:

- Review its methods for scheduling in order to, if possible, shorten the pilotages that exceed 3–4 hours. (See section 3.3.3) *(RS 2017:05 R1)*
- Investigate how it may be possible to increase the regularity of pilots' rest periods while on duty. (See section 3.3.2) *(RS 2017:05 R2)*
- Develop guidelines or other assessment support for the decision of the pilots to refuse pilotage in case a vessel is not deemed to be seaworthy. (See section 3.3.1) *(RS 2017:05 R3)*

The Swedish Accident Investigation Authority respectfully requests to receive, **by 15 February at the latest**, information regarding measures taken in response to the recommendations included in this report.

On behalf of the Swedish Accident Investigation Authority,

Helene Arango Magnusson Dennis Dahlberg