KAREN DANIELSEN
Collision with the Great Belt West Bridge
3 March 2005

The joint Bahamas Maritime Authorities & Danish Division for Investigation of Maritime Accidents report

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The casualty report was issued on 17 August 2005.

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BMA case: 8000614/2005/5127

The casualty report will be available from the Bahamas Maritime Authority and on the Internet: www.dma.dk

Introduction

This joint casualty investigation report has been made with close cooperation between the Bahamas and the Danish Maritime Authority.

The casualty report is based on both joint and independent investigations of the incident, plus the preliminary report which the Danish Division for Investigation of Maritime Accidents issued on 18 March 2005.

The Bahamas Maritime Authority
The Bahamas Maritime Authority investigates incidents at sea for the sole purpose of discovering any lessons which may be learned with a view to preventing any repetition. It is not the purpose of an investigation to establish liability or to apportion blame, except in so far as emerges as part of the process of investigating that incident.

It should be noted that the Bahamas Merchant Shipping Act, Section 170(2) requires officers of a ship involved in an incident to answer an Inspector's questions fully and truthfully. If the contents of a subsequent report were submitted as evidence in court proceedings relating to an accident this could offend the principle that a person cannot be required to give evidence against himself. The Bahamas Maritime Authority would only make a report available to an interested party on the strict understanding that it would not be used as evidence in any court proceedings anywhere in the world

The Division for Investigation of Maritime Accidents – Danish Maritime Authority

The Division for Investigation of Maritime Accidents is responsible for investigating accidents and serious occupational accidents on Danish merchant and fishing ships. The Division also investigates accidents at sea on foreign ships when Danish ships are involved.

The purpose of the investigations is to clarify the actual sequence of events leading to the accident. With this information in hand, the Danish Maritime Authority and others can take measures to prevent similar accidents in the future.

The aim of the investigations is not to establish legal or economic liability.

The Division's work is separated from other functions and activities of the Danish Maritime Authority.

When a Danish merchant or fishing ship has been involved in a serious accident at sea, the Division for Investigation of Maritime Accidents must be informed immediately.

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Glossary of Abbreviations

GPS	Global Positioning System
AIS	Automatic Identification System
VTS Great Belt	Vessel Traffic Service Great Belt
ISM	International Safety Management
WP	Way Point (turning point)
WGS	World Geodetic System

Contents

1 Executive Summary

The KAREN DANIELSEN was a Bahamas registered general cargo ship of 3120 gross tonnes, which was built in 1985 and collided with the Great Belt West Bridge shortly after departure from the port of Svendborg in Denmark.

KAREN DANIELSEN departed from Svendborg with a pilot on board on 3 March 2005 at 1630 hours bound for Finland, in ballast, with a draft of 4.6 m.

At 1706 hours the pilot informed VTS Great Belt that the vessel was sailing towards Thurø Rev bound for Finland and would pass around Vresen (north of Langeland). After this, it would head south through the Great Belt.

At 1715 hours the pilot left the ship when it was off Thurø. At this time the master and the 2nd officer were on the bridge. The 2nd officer was at the helm.

At 1720 hours the steering was changed to auto pilot. The course was 026° from 1730 hours.

At 1800 hours the 2nd officer's duty ended, and he left the bridge at approximately 1805 hours.

At approximately 1815 hours the chief officer came to the bridge and shortly after, the master left to eat. After this, the chief officer was alone on the bridge.

At 1820 hours when KAREN DANIELSEN was off Stokkebaek Flak, the course was altered to 005°. The speed was 11.5 knots. It was twilight and the weather was clear.

At approximately 1857 hours the ship was due to alter to an easterly course to pass north of Langeland according to the passage planning inserted in the GPS. However, the ship continued on a course of 005°.

At approximately 1907 hours KAREN DANIELSEN collided with the western section of the Great Belt Bridge (West Bridge) approximately 800 m from Fyn. The foremast hit the bridge first and was bent astern. Then the forward crane hit and collapsed onto the hatch. After that, the aft crane hit and fell into the water. Finally, the superstructure hit the bridge and the entire wheelhouse was torn off, together with the funnel.

At 1912 hours the ship transmitted a Mayday distress signal, and the VTS Centre realised that something was wrong.

The VTS Centre called the police, Storebælt A/S (The Great Belt Link) and DSB (Danish Rail), and the traffic over The Great Belt Bridge was stopped. Furthermore, the VTS Centre ordered the guard vessel VTS 3 from Slipshavn to sail towards the bridge.

VTS 3 and the vessel Y 376 took the crew from KAREN DANIELSEN on board and they were brought to Sliphavn. The master was injured severely in the collision and another crewmember was injured during the rescue. The chief officer was missing and a search was organised, but he was not found.

At approximately 0100 hours after the damage to the bridge had been examined, a tug pulled KAREN DANIELSEN clear and the ship was towed to Lindholm Harbour.

At approximately 0130 hours 4 March, the Great Belt Bridge was reopened for road and rail traffic.

On 4 March at 1240 hours, the chief officer was found dead in the wreckage of the wheelhouse on board the KAREN DANIELSEN. At the post-mortem examination, the result of the alcohol test proved to be at least 1.55 0/00.

Photo: The Bahamas maritime Authority, May 2004

2 The Investigation

The Danish Division for Investigation of Maritime Accidents and the Bahamas Maritime Authority (BMA) have cooperated closely during the investigation of the accident and the production of the joint report.

Immediately after KAREN DANIELSEN was brought to Lindholm, Nyborg, investigators examined the material found among the wreckage of the wheelhouse.

The investigators have taken statements from the master and the crewmembers.

The investigators have received information from NORDANE SHIPPING A/S who were the technical managers of the ship.

The Danish Police have provided statements from the questioning of the master and crewmembers and the autopsy report for the deceased chief officer.

The investigators have taken a statement from the pilot who piloted the KAREN DANIELSEN from Svendborg on 3 March 2005.

The investigators have received statements, information and documentation from:-

- VTS Great Belt,
- A/S Storebælt (Great Belt Ltd)

- Banedanmark (Danish Rails), the remote-controlled unit in Roskilde.
- AIS information from the Royal Danish Administration of Navigation and Hydrography.

3 Factual Information

3.1 Accident data

Type of accident (the incident in details)	Collision with bridge
Character of the accident	Navigation accident
Time and date of the accident	3 March 2005 at 1907 hours (Danish time)
Position of the accident	55°18,15' N - 010°52,26' E
Area of accident	The Great Belt
Deceased persons	The chief officer
Injured persons	The master injured his upper body severely in the accident. One crewmember damaged his eye severely during the rescue.
Evacuation of injured persons	The crewmembers who survived were evacuated by a guard vessel from VTS Great Belt
Ship abandoned (usage of either life boat or life raft)	The ship's own boats and rafts were not used.
IMO Casualty Class	Very serious

3.2 Navigation Data

Stage of navigation	Navigation in confined waters
Port of departure	Svendborg
Date and time of departure	3 March 2005 at 1630 hours
Depth of the time of the accident	3.4 m foreward, 4.6 m aft
Pilot on board	No

3.3 Ship data

Name	KAREN DANIELSEN
Home port	Nassau
Call sign	C6SW4
IMO No	8500070
Register	Bahamas
Flag State	Bahamas
Construction year	1985
Type of ship	Cargo ship
Tonnage	3120 GT
Classification	Germanischer Lloyd
The Owner	Otto Danielsen
Technical Management	Nordane Shipping A/S
Length	88.6 m
Engine power	2220 kW
Hull construction	Single hull, double bottom
Area served	World wide (GMDSS A1+A2+A3)
Regulation	SOLAS

KAREN DANIELSEN had valid certificates.

During KAREN DANIELSEN'S stay in Cadiz on 8 February 2005 a Port State Control inspection was held on board. The ship received no deficiencies during the inspection.

3.4 Weather data

Wind – direction and speed	Almost calm
Sea	Little sea
Current	No current of importance
Visibility	Good, more than 5 nautical miles
Light conditions	Nautical twilight
Sunset	At 1755 hours*
"Borgerligt" twilight	Ended at 1832 hours*
Nautical twilight	Ended at 1914 hours*

*Source: Nauticala for Denmark

3.5 The Crew

Watch	3 shift watch
Number of crewmembers required by the "Minimum Safe Manning Document"	• 3 navigators incl. the master • 2 ABs • 2 engineers • 1 motorman • 1 cook
Crewmembers employed on board the ship at the time of the accident	Certificates etc.
Master	• 60 years • STCW certificate as Master on ships over 3000 GT • STCW certificate as GMDSS radio operator • STCW certificates for Medical care, first aid, fire fighting, dangerous cargo etc. • Master since 1973 • Employed in the company since 1997 • Signed on 8 February 2005 • Third period on board this ship, totalling approx. 10 months
Chief Officer	• 37 years • STCW certificate as Master on ships over 3000 GT • STCW certificate as GMDSS radio operator • STCW certificates for Medical care, first aid, fire fighting, dangerous cargo etc. • Signed on 22. February 2005 • Second period on board this ship,

	totally approx. 12 months
2nd officer	31 years • STCW certificate as mate on ships over 3000 GT STCW certificate as GMDSS radio operator STCW certificates for Medical care, first aid, fire fighting, dangerous cargo etc. Signed on in Svendborg on 3 March 2005 4th period in the company. First time on board this ship
Chief Engineer	55 years STCW certificate as chief engineer on vessels under 3000 kW • STCW certificate as 2nd engineer on vessels over 3000 kW • STCW certificates for Medical care, first aid, fire fighting, dangerous cargo etc. • Signed on 22 February 2005 • 32 years at sea • Chief engineer since 1980 • First period in this company
2nd Engineer	24 years • STCW certificate as engineer on vessels over 750 kW • STCW certificate as 2nd engineer on vessels under 3000 kW • STCW certificates for Medical care, first aid, fire fighting, dangerous cargo etc. • Signed on in Svendborg 3 March 2005 • 2nd period in this ship
AB	• 40 years • STCW certificates for Medical care, first aid, fire fighting, bridge watchkeeping certificate (look-out) • Signed on 3rd December 2004
AB	• 58 years • STCW certificates for Medical care, first aid, fire fighting, bridge watchkeeping certificate (look-out) • Signed on 3rd March 2005
Ordinary Seaman	• 39 years • STCW certificate for basic training • Signed on in Svendborg on 3 March 2005 • This was his first period on this ship

	• It was his third period for the Owner
Motorman	• 44 years • STCW certificate for basic training and operation and maintenance of live-saving appliances • Engineroom watchkeeping certificate • Signed on in Svendborg on 3 March 2005
Cook/steward	• 38 years • STCW certificates for basic training • Third period for the Owner

KAREN DANIELSEN was manned according to the Safe Manning Document and the crewmembers held the required statutory certificates.

All the crewmembers had Croatian nationality. An Austrian shipping office Marineconsult with offices in Croatia engaged the crew for the owner.

3.6 Narratives

KAREN DANIELSEN called at Svendborg on 2nd March 2005 after a voyage from Newport, Wales. The ship planned to take bunker, provision, stores, have a new radar fitted and the ballast tanks inspected, in preparation for class renewal survey. Furthermore, five crewmembers were going to sign off and five new crewmembers were going to sign onto the ship.

Upon departure from Svendborg, the ship intended a ballast voyage to Mäntyluoto, Finland for loading.

Before departure from Svendborg, the wheelhouse was checked in accordance with the ship's new "pre departure check list". The 2nd officer who signed off in Svendborg had prepared the passage plan and it had been inserted in the GPS and as well as on the relevant charts.

According to the passage plan, the ship was transiting between Fyn and Langeland north of Vresen and south towards Route H in Langelandsbælt (east of Langeland).

The ship departed from Svendborg on 3 March 2005 at 1630 hours. The pilot had boarded the ship at 1615 hours.

Navigation was by use of traditional paper charts. Two radars were in service. One of the radars was set on the 3 nautical miles range and the other radar was set on the 12 nautical miles range.

The pilot, the master and the 2nd officer, who had signed on recently, were in the wheelhouse. They steered manually and the 2nd officer was the helmsman. The chief officer was at mooring stations forward with one AB. The other AB and the OS were at mooring stations aft.

The chief engineer, 2nd engineer and the motorman were all in the engine room.

The cook was preparing the evening meal.

At approximately 1706 hours, the pilot reported the ship's data and passage plan to VTS Great Belt**.** The report was received and acknowledged by VTS Great Belt.

At 1715 hours the ship was south of Thurø Rev and the pilot departed.

At approximately 1720 hours upon the pilots departure the 2nd officer changed from manual steering to auto pilot, the speed was being gradually increased to full speed ahead and the gyro course set to 026°.

The chief officer came to the bridge at approximately 1730 hours to speak with the master and discuss the instructions for the crew. After they had spoken the master told the chief officer to go and get cleaned up (after working on deck) then to have dinner before coming back to the bridge to take over the watch.

The 2nd officer fixed the vessels position at 17:45 by GPS and the chief officer left the wheelhouse at around this time. At 18:00 the 2nd officer fixed the vessels position again by GPS, the vessel was 0.03 n. miles to West of track and the 2nd officer made a small course alteration of course to 027° upon the master's instructions. The master retained the conn of the vessel throughout.

The 2nd officer left the bridge at 1805 hours and the master remained on the bridge alone. The 2nd officer went briefly to his cabin to wash his hands and then down to dinner. The chief officer and chief engineer were also in the officers' mess room at this time, there was a pitcher of water available on the table, but no alcohol.

The master remained on the bridge until approximately 1815 hours where the chief officer came back to the bridge and took over the watch. When the master handed over the watch to the chief officer, he informed the chief officer that the ship was close to the next waypoint (WP 106). The master observed visually the east cardinal buoy at WP 106, he then left the wheelhouse and went to eat dinner in the officers' mess. It was his intention to return to the wheelhouse after his meal.

At approximately 1815 hours, shortly after taking over the watch, the chief officer called down to the crew mess room via the ship's intercom system for an AB and told him to go forward to the forecastle and switch off the forward mooring light, which had been left on.

It was twilight, very clear weather and good visibility.

There was an entry in the chief officer's (deck) log book that at 1820 hours, the chief officer altered course to 005° at waypoint 106, as per the passage plan.

When the master had finished his meal at approximately 1905 hours, he left the officers' mess and was on his way to the wheelhouse, he stopped briefly at the crew mess room to say good evening.

At 1907 hours KAREN DANIELSEN collided with the Great Belt - West Bridge between the pillars no. 52 and no. 53.

The ship's course and the ship's speed had remained unaltered since 1820 hours.

3.7 The vessel's collision with the Great Belt West Bridge

The ship hit the West Bridge at a speed of 11.5 knots, on a course of 005° and collided with the bridge span between pillars No 52 and 53.

On its way under the West Bridge motorway span, the ship's fore mast was torn from the deck and bent aft, the starboard bow hit a glancing blow against pillar No. 52 and was damaged as a result. Then the bridge span brought down the ship's forward crane which broke off at its attachment flange and landed across the hatchway on deck. The aft crane was also torn off at its attachment flange and lost overboard into the sea and finally when the wheelhouse hit, it was cut off at deck level and pressed astern to finally rest on top of the funnel. The funnel was torn off at its attachment to the deck and laid horizontally aft, with the wheelhouse on top of it. The ship was wedged firmly under the motorway bridge span and brought to a stop against the railway bridge span, which is slightly lower than the motorway. The ship's engines were still at full ahead upon impact.

Photos: TRYG Insurance

After the collision, the main engine continued running at full ahead, they were stopped on the master's orders, when he told the 2nd officer to go to the engine room and tell the engineers to stop the main engine immediately.

The chief engineer, 2nd engineer and motorman, were all present in the engine room at the time of the collision and felt the impact. The chief engineer realized something was seriously wrong, he and the 2nd engineer immediately changed from the shaft generator, back onto the diesel generators. When they had the diesel generators on

line, the 2nd officer came running into the engine control room and told them to bring the main engine to an emergency stop, which they did immediately.

During the examination of the wheelhouse wreckage the day after the collision, it was found that the chief officer was sitting in the portside seat of the wheelhouse when the collision occurred.

3.8 Damage to the Great Belt West Bridge

The ship's starboard bow hit the concrete bridge pillars which supports the motorway and rail bridges (Pillar No 52). The ship's superstructures made a hole in the concrete girder below the motorway bridge.

Great Belt West Bridge pillar No 52, with motorway section on the right and rail section on the left.

3.9 Supplementary information from the ship's crew about the collision

Master:
At the time the collision happened, the master was on his way from the officers' mess room to the wheelhouse. He was on the upper section of the stairway which led into the wheelhouse when he felt a severe impact to his upper body and he was knocked backwards down the stairway. He was seriously injured in the collision.

2nd Officer:
After he left the bridge the 2nd officer was eating dinner in the officer's mess until around 1835 hours and then went to his cabin. At about 1900 hours he returned to the

mess room to ask the cook for clean bed linen and towels, the cook was with the master in the officer's mess and clearing up after dinner. The cook asked the 2nd officer to wait for a few minutes until he cleared up, so the 2nd officer waited in the crew mess room.

The 2nd officer was waiting in the crew mess room at 1905 when the master stopped briefly on his way to the wheelhouse to wish the crew a good evening.

At around 1909 he heard a crash, the first of four in succession, after the first impact the ship rolled severely.

The 2nd officer and other crewmembers suspected that the vessel had been involved in a collision and they ran out on deck to see that the West Bridge pillar was situated along the starboard side and the vessel was under the Bridge.

The 2nd officer then proceeded to the wheelhouse and found the master in the stairwell leading to the wheelhouse, badly injured. The 2nd officer helped the master to a comfortable position on the deck at the bottom of the wheelhouse stairway.

The engines were still going at this time and the master instructed the 2nd officer to stop the engines, the 2nd officer ran to the engineroom and ordered the emergency stop of the main engine.

The 2nd officer then returned to the injured master who instructed him to transmit a "Mayday" call. The 2nd officer tried to enter the wheelhouse but came up against the underside of the West Bridge, there were rocks falling down into the ship at this time and he was disorientated when he came up against the underside of the West Bridge span. He then went to his cabin to get one of the handheld emergency VHF's (each officer had a handheld VHF in his cabin) he called "Mayday" on VHF Channel 16 advising that the "Karen Danielsen" had hit the Great Belt Bridge.

The ship’s fire alarms were now going off and the 2nd officer believed a fire had started, he advised all stations again calling "Mayday" on VHF 16 that the vessel was on fire, it later transpired that this was caused by exhaust gas entering the engine room from the damaged funnel and electrical short circuits.

The 2nd officer then went to check the ships lifeboat, which was a stern launched, free fall arrangement to see if it could be launched, this was not possible due to the damaged funnel and wheelhouse being in the way.

The rescue boat eventually arrive on the scene and the 2nd officer proceeded to assist with the crew evacuation. The Cook slipped on ice on deck when he boarded he rescue boat and badly damaged his eye against a window securing dog.

Cook:
The cook was in the galley preparing the evening meal which was ready around 17:30 hours. About this time, the chief officer entered the mess room and had his dinner. The cook and the chief officer had a brief conversation and the chief officer finished his meal and left the mess room shortly after 1800 hours.

Approximately between 1800 and 1900 hours the other crewmembers had their dinner and then the new crewmembers received their bed linen and towels from the cook.

One AB was in the mess room and the other AB was in his cabin.

The ordinary seaman was cleaning the crew accommodation.

The engineroom:
The chief engineer and 2nd engineer were in the engine control room reading maintenance manuals. The motorman was also in the engine room.

Chief engineer:
The chief engineer felt the impact of the collision in the engine room and a sudden change of course followed by several more bumps in succession. The chief was thrown against the 2nd engineer, then backwards and grasped a hand rail to hold onto, neither he nor the 2nd engineer was injured.

The engineers thought that the ship had hit an ice formation or another vessel or grounded and immediately started both auxiliary generators to prevent a "black out" in case the main engine needed to be stopped. At the time of impact the shaft generator was the only generator in service.

The engineers were not sure what had happened until the 2nd officer entered the engine room and shouted for them to stop the main engine, because the ship had collided with a bridge.

The engine room filled with dust and smoke at this time, which activated the automatic fire alarm, but no fire had broken out. It later transpired that this was caused by exhaust gas entering the engine room from the damaged funnel and electrical short circuits.

The assistant engineer tried to telephone to the wheelhouse but did not get any response, so the chief engineer left the engine room to find out what had happened, he then returned to the engine room.

Immediately after the collision the motorman ran to the deck and saw that the ship had hit the Great Belt Bridge. Concrete fragments from the bridge were falling down upon the ship and there was a lot of chaos due to the substantial damage and location of the vessel.

3.10 Evacuation from the ship and the search

The crew on board KAREN DANIELSEN gathered on the port side of the main deck.

The second officer and the cook collected some of the ship documents from the master's cabin which were handed over to the police and then passed on to the Danish Investigation Division.

VTS Great Belt called the guard vessel VTS 3 from Slipshavn to KAREN DANIELSEN. At 1930 hours, the vessels from the Danish Navy Y376 and RAVNEN and the vessel MHV GEMINI from the Danish Naval Home Guard were sent from Naval Station Korsør.

At 1949 hours, VTS 3 informed VTS Great Belt that they had taken six crewmembers on board, that one of the crewmembers had been severely injured (master) and that another crewmember had been slightly injured (cook). VTS 3 brought the six crewmembers to Slipshavn where the police and the ambulances awaited them.

The two injured persons, the master and the cook, were brought to Odense University Hospital by ambulance together with a crewmember who spoke English well and who worked as interpreter to assist the two injured crewmembers.

At 2003 hours, the vessel Y376 had reached KAREN DANIELSEN and it evacuated three crewmembers. One of the crewmembers, the chief officer, was missing. The three crewmembers remained on board Y376 until approximately 2200 hours when two of them, the chief engineer and the second engineer went back on board KAREN DANIELSEN to secure the ship's electricity supply and help the salvage personnel.

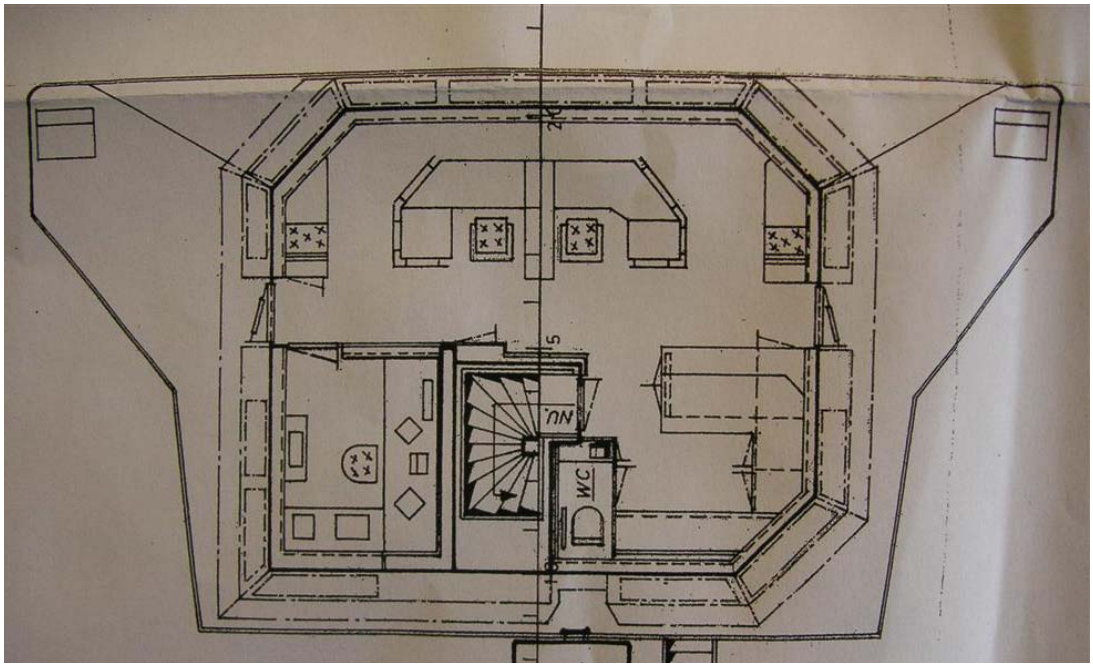
The third person they took on board Y 376 was brought to Slipshavn at approximately 2230 hours.

There was a comprehensive search for the missing chief officer in the accident area by RAVNEN, VTS 3, MHV GEMINIA, other home guard and fishing vessels, together with rescue helicopters which participated in the search.

At 0127 hours, the search was abandoned, the chief officer had not been found.

3.11 Wheelhouse arrangement

The description is based on drawings, pictures and information from the master, the 2nd officer and other crewmembers with knowledge of the ship.



E-deck (wheelhouse) – extract from "general arrangement" dated 29 August 1986.

Bottom left, (Port side) was the radio room.

Bottom right, (Starboard side) was the chart room.

Front centre, was the control consul with two seats.

The ship's two radars were situated in front of the two seats. The newly fitted radar was installed in front of the seat which the chief officer regular used on the port side. From this seat it was possible to switch between auto pilot and manual steering. The vessel could also be manually steered from this position by the use of a joint stick.

Three VHF sets were situated adjacent to the seats.

There were two GPS receivers; one was situated on the control consul near the seats, the other was situated above the chart table. The passage plan had been inserted into the GPS Navigator, type GN 33, situated above the chart table – *see photo of chart room.*

A bridge watch (dead man) alarm system was situated between the control consul seats. The alarm can be set to give a "buzzer signal" in the wheelhouse at 5, 10 or 15 minutes' intervals. If the alarm was not cancelled by activating a push button it would (after two minutes) activate the general alarm throughout the ship.

According to the master's statement, the bridge watch (dead man) alarm system was not switched on when he handed over to the chief officer and left the wheelhouse.

Radio equipment: GMDSS A1 + A2 + A3.

The photos below were taken in May 2004 by a Bahamas Maritime Authority Inspector.

KAREN DANIELSEN wheelhouse, photographed from starboard to port side.

The chartroom photographed from aft. The GPS can be seen on the right-hand side.

3.12 Voyage Planning

The passage plan from Svendborg to Mantyluoto, Finland was prepared by the departing 2nd officer and was checked together with the joining 2nd officer, as part of their handover procedure. Neither the hard copy of the passage plan nor the charts in use could be found in the wreckage of the wheelhouse.

The ring binder containing the previous passage plans was found on board by the accident investigators, including the voyage from Newport to Svendborg.

Detailed route information for the voyage in question was, however, stored in the GPS Navigator, which was found in the remains of the destroyed wheelhouse. The GPS Navigator proved to be fully operational.

The manufacture, SIMRAD AS, advised that the GPS Navigator was installed on the ship on 3 March, 2003 and that the GPS antenna was an ordinary “GPS 4” antenna without differential features. The GPS equipment had a position accuracy of approx. 15 meters. The antenna was placed on top of the after part of the wheelhouse on the starboard side, above the GPS Navigator.

The GPS Navigator was examined and tested by the investigators in co-operation with the manufactures technicians in their service department.

SIMRAD GN33 GPS Navigator

Among other passage plans, which were stored into the GPS Navigator, was the actual passage plan from Svendborg to Mantyluoto, Finland, for the current voyage.

The following alteration of course positions (waypoints) for the planned passage from Svendborg, north of Langeland and then south through the southern part of the Great Belt, have been extracted from the GPS Navigator.

Starting point of each leg	Remarks	COG	Distance	Ending point of each leg
WP 106 55°09,650' N – 010°51,150' E	Cardinal buoy at *"Stokkebæk Flak"*	005°	6,6 NM	WP 107
WP 107 55°16,250' N - 010°52,099´E	North of *"Vresen"* 1,88 nautical miles south of the westbridge.	090°	2,1 NM	WP 108
WP 108 55º16,250´ N 010º55,750´E	Crossing the Deep Water Route towards buoy No. 2 in Route H	149°	7,3 NM	WP 109 55°10,000' N - 011°02,299' Ø

See pictures of the reconstruction in Chapter 9 - Enclosures

Further information from the examination of the GPS Navigator

During the examination and immediately after the GPS Navigator was turned on, it started beeping and *"Line Alarm"* was shown on the display, this is a warning signal and an indication that a waypoint has been passed.

According to the manufacturer's technicians, this was the same display that was shown at the time of the accident, i.e. at the time when the power supply was cut off.

A back up function in the GPS Navigator ensures that after an unintentional loss of power supply (as in this case), the GPS will re-start at the same display as was shown before the power was lost. However, if the power is switched off via the instrument's *PWR* button the main menu will be shown when it is turned back on.

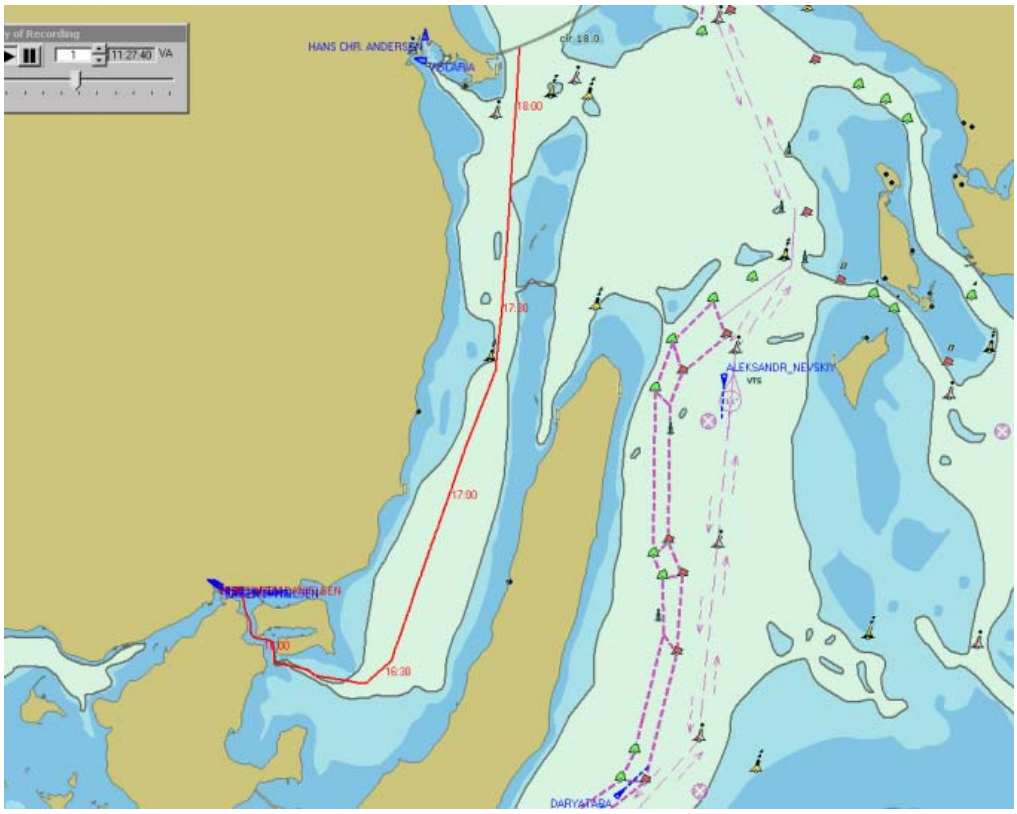
Therefore, the "Line Alarm" had been sounding in the wheelhouse from the time that KAREN DANIELSEN passed WP 107 and the alarm continued to sound until the ship collided with the bridge approximately 10 minutes later.

3.13 Charts

The ship received several sea charts during a brief stop off Grenå in order to make the additional port call at Svendborg, they received the northern, mid and southern part of the Great Belt (BA 2596 – BA 938 – BA 2597).

3.14 AIS

KAREN DANIELSEN was equipped with AIS. The ship's movements from the time of the departure from Svendborg and until it collided with the bridge were registered by the *Royal Danish Administration of Navigation and Hydrography*



Extract of the AIS plot from the Royal Danish Administration of Navigation and Hydrography´s display system. Times shown on the plot is UTC (Local time – 1 hr)

The AIS information shows that KAREN DANIELSEN from 18.20 hours and until the vessel collided with the bridge maintained the same course and speed of 005º and 11.5 knots respectively.

3.15 Working/resting hours

The usual bridge watches kept by the deck officers at sea, are as follows:

Master	1000 – 1200 and 2200 – 2400 hours
Chief Officer	0400 – 1000 and 1800 – 2200 hours
2nd officer	0000 – 0400 and 1200 – 1800 hours

KAREN DANIELSEN arrived to Svendborg on 2 March 2005 at 0800 hours. According to the master's statement, they did not work in the evening or during the night between 2 and 3 March 2005.

The chief officer was on sea watch on 2 March 2005 between 0400 and 0800 and then he was working throughout the day with the crew and the Nordane Superintendent.

On 3 March 2005 the chief officer worked from the morning throughout the day, the only rest he had were his meal breaks. He then took over the sea watch at 1815 hours and he was on duty until the accident occurred at 1907 hours. He was due to remain on duty until 2200 hours under the normal sea watch keeping rota.

According to some crew statements the chief officer had said he was very tired on the 2 March, the day before the accident.

The chief officer was off duty from late afternoon on 2 March 2005 until the next morning. The chief and 2nd officer shared the night watch in port. As the vessel was not working during the night (2nd / 3rd March) an AB kept the port watch, the deck officers were on call, but could sleep in their cabins.

There are no statements from the master or from the crewmembers about having observed tiredness in the chief officer on 3 March 2005, the day of the accident.

The chief officer had probably been in his cabin during the night of 2 / 3 March 2005. Nobody had seen him go ashore in Svendborg.

The 2nd officer together with four other new crew members joined the vessel around 1000 hours on 3 March 2005 after travelling by mini bus from Split in Croatia to Svendborg, in Denmark. This was a direct drive of 26 hours, they were accompanied by two drivers and a crew manager from the manning agency. Upon arrival at the ship they went through their respective handovers and the departing crew members left to return to Croatia with the same mini bus shortly after 1400 hours on 3 March. The joining crew went straight on duty upon arrival at the vessel.

Due to the busy work schedule planned for the 3rd March, all on board, both existing and newly joined crew worked throughout the day on the 3 March 2005.

3.16 The Owner Organisation

The KAREN DANIELSEN was one of five sister ships constructed in 1985 and 1986. The shipping company, Otto Danielsen owned the ships and performed the technical management.

Nordane Shipping A/S, based in Svendborg Denmark, took over the technical management of the ships on 15 December 2004.

At the time of the accident Otto Danielsen still maintained responsibility for the engagement of the crew, this aspect of the technical management had not yet been handed over to Nordane . The engagement of the crew was made through the Austrian Manning Agency, Marineconsult, which also has offices in Croatia.

3.17 ISM

Nordane Shipping A/S, attended to the technical management of the ship and were responsible for the ISM procedures on board.

Germanischer Lloyd (GL) held an *"external pre-audit"* on board KAREN DANIELSEN on the 3 January 2005 in Harlingen, Holland. The ISM *Designated Person Ashore* (DPA) from Nordane Shipping A/S was on board and handed over the new ISM manual to the ship.

On 3 January 2005 GL issued an interim "Safety Management Certificate" (SMC) to the ship and an interim "Document of Compliance" (DOC) to Nordane Shipping A/S.

In accordance with normal practice an *"internal audit"* should be held on board the ship within three months from the issuing of the interim certificates and an *"external initial audit"* by GL within six months. Nordane Shipping A/S was advised accordingly in a letter from GL.

According to Nordane Shipping´s audit plan, the audits should be held in March and May 2005.

During KAREN DANIELSEN´s stay in Svendborg, the DPA and the master decided to postpone the internal audit until the ship arrived at Trieste, Italy in April, because the master had not had sufficient time to get familiar with the new ISM-manual.

Nordane Shipping A/S had elaborated upon and amended the ISM-manuals, which were handed over to the Otto Danielsen owned ships, with corrections and supplementary information for each ship.

The annual ISM audit at Nordane Shipping A/S was normally held by Bureau Veritas (BV) and in agreement with GL. The last audit at Nordane Shipping A/S was held by BV on 1 September 2004.

The Company drug and alcohol policy, together with guidance for watch keepers was included in the ISM manual.

Following the accident, Bureau Veritas has, on the instruction of the flag state Bahamas, made an additional ISM audit at Nordane Shipping, with instruction for particular attention to be paid to items associated with the casualty:-

There were two non-conformities identified from the ISM audit:-
1) The bridge watch (dead man) alarm system fitted on board KAREN DANIELSEN was not mentioned in the Nordane Safety Management System (SMS).
2) There was a discrepancy over the employment of the crew; the master, officers and crew onboard the vessel was employed by the Owner (Rederiet Otto Danielsen) through the agency Marine Consult in Croatia. The Nordane SMS procedures describe this function as being performed by the Nordane Crew / Purchasing Manager.

3.18 The ship's stay in Svendborg

The port call into Svedborg was a late decision by Nordane Shipping A/S, the objectives of the port call were:

1) For Nordane office staff could familiarize themselves with the vessel,
2) To update ISM procedures,
3) To prepare for the Class renewal survey, carrying out the ballast tank inspections,
4) To install the new radar,
5) To take bunker fuel,
6) For the exchange of the five crew members.
7) To take stores and provisions,
8) To service the fire extinguishers.

This decision was taken because the vessel had some spare time within the commercial schedule.

During KAREN DANIELSEN's stay in Svendborg, several employees from Nordane Shipping were on board the ship.

The company's surveyor was on board the ship in preparation of the upcoming 20 year class inspection. Nordane Shipping A/S had employed the surveyor, who is a trained engineer, with approximately 13 years experience.

The ballast tanks were inspected under the supervision of the surveyor, who was assisted by the ship's crew.

One new radar was installed, the new radar was a Furuno radar and a certified electrician did the installation.

The tank inspections and the installation of the new radar were started on the 2 March in the morning and were finished on the 3 March in the afternoon.

3.19 Change of crew

During the ship's stay in Svendborg, five crewmembers were replaced by five new crewmembers; the 2nd officer, 2nd engineer, one AB, the OS and the motorman.

The change of the Crew was made by bus transport from and to Split, Croatia.

The bus with the new crewmembers arrived at the ship at approximately 1000 hours on 3 March, after a 26 hour drive and just after 1400 hours the bus left on the return journey with the crew that had signed off.

The master had joined the ship at Cadiz on the 8 February, the chief engineer and the chief officer both joined the ship on respectively 22 and 23 February.

3.20 Look-out / watch keeping

The master has stated that he did not order a designated look-out to the bridge because they only used a look-out in very narrow waters or under exceptional circumstances, such as restricted visibility.

The AB who remained on board KAREN DANIELSEN advised that the deck crew normally worked as day crew from 0800 to 1700 hours. The deck crew only worked as look-out on the bridge under special circumstances, for example in restricted visibility or bad weather.

The accident occurred at 1907 hours. The sun went down, in the position in question, on 3 March 2005 at 1755 hours.

Extract from the ship's ISM manual regarding watch keeping

"Procedure: Under normal circumstances, when the ship is at sea, there often will be only one watch officer alone on the bridge, taking into account the master's and company's standing orders.

It must be clear from the master's standing orders under which conditions look-out has to be established, and it must be clear at the beginning of the watch, who has to be look-out when needed. Both parts must be informed about this.

Look-out has to be established when navigating in near shore, in situations with heavy traffic intensity, low sight or other navigational critical situations.

Look-out must not carry out other duties in the period where the situations are a described above. The look-out must not leave the bridge for visit to toilet, looking for coffee or other things, without permission from the officer on duty.

Under the absence of the look-out the officer must not carry out any other work than ensure the vessel's safe navigation.

If one of the deck crew is on duty as look-out, the name of the person concerned has to be noted in the logbook."

Extract from the master's standing order in the Bridge Night Orders Book

"1. The OOW (officer on watch) must at all times comply with applicable International REGULATIONS FOR THE PREVENTION OF COLLISION AT SEA, and ensure a proper look out is kept at all times. It is essential that the vessel is at all times navigated at a safe speed having due regard to the traffic density and prevailing weather conditions and navigational hazards in vicinity.

2. The OOW is to maintain his watch on the bridge until properly relieved. Should the OOW have any reason to believe that relieving officer is unable to carry out his watch keeping duties effectively, then he should not hand over the watch and inform the Master immediately."

Chief officer's log book
The deck log book, named the "*Chief Officer's Log Book"* was found on board in the wheelhouse wreckage after the collision. The book had been in use from 5 February to 3 March 2005 and was signed by the master and the chief officer for each day. It is not necessary for this log book to be authorised by the Bahamas Maritime Authority, this is a statutory requirement for the "Official Log Book" (which was not recovered from the wreckage). The maintenance of a deck and engine room log book is a requirement for record keeping.

In the deck log book were entered the names and watch periods that each seaman has been on "look-out" duty 24 hours a day, when the ship was at sea. During the course of the investigation it became apparent from the evidence gathered that the seaman apparently has been on call, but was not necessarily present in the wheelhouse, performing "look-out" duties during these periods.

Both the master and an AB stated that there was only a look-out on duty in the wheelhouse under special circumstances.

The ISM- manual says: "*If one of the deck crew is on duty as look-out, the name of the person concerned has to be noted in the logbook."*

Regulation on watch keeping
International rules for watch keeping and look-out are described within the STCW Convention 1978 and the associated Code (as amended), that both the Bahamas and Denmark have acceded to.

According to the Code A-VIII/2, Section 14, a look-out has to be able to use his full attention on keeping a proper look out. The look-out cannot do tasks that may interfere with this duty.

According to the Code A-VIII/2, Section 15, the officer in charge of the navigational watch may be the sole look-out in daylight provided on each such occasion that the situation has been carefully assessed and it has been established without doubt that it is safe to do so.

3.21 Bridge watch alarm

A bridge watch (dead man) alarm system was fitted between the chairs on the wheelhouse control consul. The bridge watch alarm could be set to give a "buzzer signal" on the bridge at 5, 10 or 15 minutes interval. If the alarm was not cancelled by a push button, the ships general alarm would sound throughout the entire ship, after approximately two minutes. The bridge watch alarm system on board the KAREN DANIELSEN was not fitted with motion or any other automatic sensors and had to be manually accepted.

According to the master, the bridge watch alarm system was not in use when he handed over the watch to the chief officer at 1815 on 3 March and left the wheelhouse.

The use of the bridge watch alarm was neither included nor mentioned in the ISM system.

Regulation on bridge watch alarm
Denmark has established new rules on demands for installation of bridge watch alarms on Danish ships. The rules have taken effect for new ships and for existing ships with a gross tonnage below 3,000 GT. The rules will take effect from 1 March 2006 for other existing ships.

There are no international regulations for the installation of bridge watch alarms in ships, at present.

3.22 Alcohol

At the post mortem examination, the alcohol test proved positive and that the chief officer had an alcohol concentration in the blood of at least 1.55 0/00

According to statements made to the Danish police, the crew could buy the beer and wine that they wanted from the cook, but the master had to give permission to buy spirits. Prior to the ship's arrival to Svendborg, the cook had sold three bottles of spirits to the crew that had signed off, in order for them to take home. He does not recall having sold any spirits to the crew that stayed on board the ship.

An AB had informed the police that he and others had a beer with their dinner just before the accident occurred.

According to the statements given to the police and the investigators, no other persons on board drank any alcohol and they did not see anyone have any alcohol on 3 March 2005. Nobody on board the ship observed anything unusual about the chief officer and they did not see any sign indicating that the chief officer was under the influence of alcohol.

When the master handed over the watch to the chief officer at 1815 hours on 3 March, the master did not notice anything unusual about the chief officer, there was no smell of alcohol, no problem with balance and nothing unusual in the way he spoke.

The precautions and the Owner's policy regarding the use of narcotics and alcohol together with the procedures for watch keeping are indicated in the ship's ISM manual which was found on board the ship after the accident.

Extract from the ship's ISM-Manual regarding alcohol

"Policy: In order to meet the international regulations, it is not allowed for neither officers nor seamen to reach a per mille higher than 0.4 o/oo and it is strictly forbidden to consume alcohol during duty and watch period.

It is required of all crewmembers that they agree to abstention within reasonable length of time before duty is to be initiated. On average it takes an hour for one drink to stabilise itself.

Ordinary beer	*33 cl*	*1 drink*
Strong beer	*33 cl*	*2.5 drink*

Spirituos	*3 cl*	*1 drink*
Table wine	*1 liter*	*10 drinks*
Dessert wine	*1 liter*	*16 drinks*

It is the Master's responsibility to control the usage of alcohol on board.

The Company recommends that the shop on board the ship does not carry strong beer and spirituous.

It is strictly prohibited to sell alcohol to persons less than 18 years of age.

Depending on the sailing area, alcohol can be strictly prohibited.

When sailing in US-waters and during stay in US-harbours all use of alcohol / beer on board is prohibited."

Regulation on alcohol
According to Danish regulations *The Act on Safety on Sea*, it is illegal if a person in charge of a ship or who otherwise carries out work on board a ship in a position of considerable importance to safety has consumed alcohol or other intoxicants to such an extent that he is unable to perform his duties in a fully reliable way.

3.23 The post mortem examination of the chief officer

At the post mortem examination, the alcohol test proved that the chief officer had an alcohol concentration in the blood of at least 1.55 0/00.

Furthermore, the post mortem examination revealed that the chief officer died as a consequence of the injuries sustained during the collision with the bridge. Nothing indicated that the chief officer had become ill prior to the collision.

4 VTS Great Belt

When the decision was taken to build the fixed link across the Great Belt it was also decided to establish a Vessel Traffic Service (VTS) system for safeguarding the link.

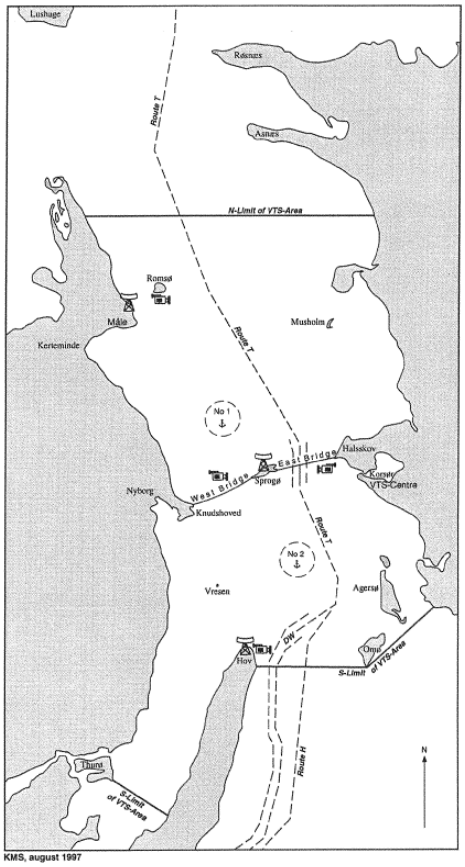
The Admiral Danish Fleet (SOK) has VTS authority and is the operational manager of the VTS-system and the operation is based upon an agreement between SOK and A/S Sund & Bælt Holding, which has economic responsibility. A division of the admiral fleet assists in the technical operation and development.

Extract from VTS Great Belt Procedure 002:

"The task of VTS Great Belt is to supervise the Great Belt traffic to protect the bridges spanning the Great Belt and to alarm in time to stop rail- and the road traffic in case of a risk of collision with the bridges.

Further more to ensure the safe navigation of vessels navigating the VTS area and the environment by:
Turning away vessels, which cannot pass under the bridges due to their construction.

Informing the traffic in order that big ships and/or ships carrying dangerous goods can avoid meeting each other in a narrow area.
Arranging pilotage service.
Bringing into action guard boat.
Providing information to mariners about local weather, current, ice, water level, navigational problems and other conditions to be specifically aware of during passage of the VTS area."



The VTS Area. Source: Order no. 86, 12/2 2004, concerning Navigation through the East Bridge and the West Bridge in Great Belt.

4.1 The organisation of the watch at VTS Great Belt

The VTS-centre is located at the Naval Base Korsoer. The watch at the centre is organised in 6 watch teams, each of which is manned by 3 persons, 1 watch leader and 2 operators. Each team is on duty for a 12 hours period, either during day from 0800 to 2000 or during night from 2000 to 0800. The normal shift is 2 days on duty – 4 days and nights off duty – 2 nights on duty – 4 days and nights off duty.
In addition, every operator has a 24 hours call-out duty approximately every 18 days.

If required due to sick personal or holidays the team leaders or operators can have more than two watches in a row. Each watch is separated by approx.12 hours off duty.

4.2 The sequence of events on 3 March 2005

Based upon the investigator's interviews at the VTS-centre on 4th March of the watch team on 3rd March.

The day watch team for the 3rd March arrived at the VTS-centre shortly before 0800 hours and a normal change of duty procedure was carried out.

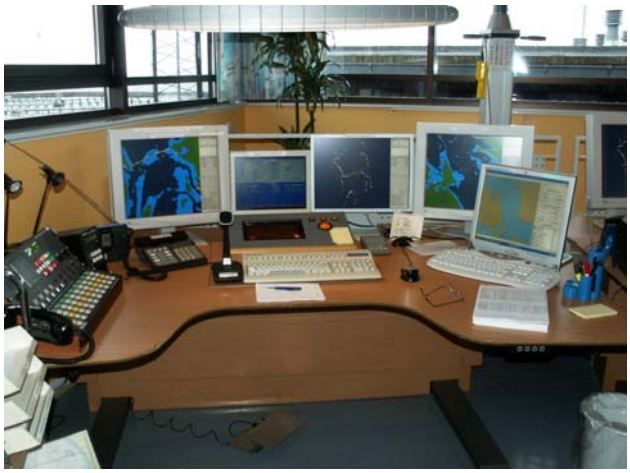
The 3 persons on the watch team all have a background as shipmasters. The team leader has experience as such back from the 1 of January 1994. Operator 1 has approximately 5 years experience as operator at VTS Great Belt and from 1995 to 1999 as team leader at VTS Drogden. Operator 2 has approximately 5 years experience as operator at VTS Great Belt and earlier on as operator at VTS Drogden.

The watch team had divided the watch into 2 hours shifts in the way, that one of them manned the operators desk and kept the actual watch, one was nearby and could be called immediately to assist the operator at the desk, the other could move around freely in the building and could be called via mobile phone.

On the actual day the shift at the operator's desk was as follows:

0800 – 1000: Operator 1.
1000 – 1200: Operator 2.
1200 – 1400: Team leader.
1400 – 1600: Operator 1.
1600 – 1800: Operator 2.
1800 – 2000: Team leader.

At the operator's desk were 3 monitors, which show the radar pictures of the VTS area. The monitor to the left showed the southern part of the VTS area, the one to the right the northern part and the middle one the whole area in a smaller scale. On the middle monitor one could zoom in at a certain part of the area. In between the left and the middle monitor is a PC monitor, which shows the VTS database. To the right hand side of the right radar monitor is another PC monitor, on which different programs could be displayed, such as the list of pilots, sent via internet by Great Belt Pilots, videos from the cameras on the bridge, meteorological data, Lloyds database and AIS information.



The desk of the operator on duty. Source: VTS's homepage

There is one more operator desk with identical radar monitors. At one of the operator desks is placed an alarm panel (see later). There are also two more operator desks with two radar monitors, a database and a multifunction monitor as on operator desk 1.

Operator 1 and operator 2 are smokers and therefore have arranged to relieve each other for 5 to 10 minutes, approximately in the middle of their 2 hours period.

Between 0800 and 1200 hours the team leader was mainly occupied by administrative work within hearing distance of the operator's desk.

At 1600 hours operator 2 took over at the operator's desk in accordance with the watch plan. At about 1700 operator 1 relieved him for a short smoking-break.

At 1706 hours Svendborg Pilot on board KAREN DANIELSEN called VTS Great Belt on VHF, channel 11. The pilot reported, that he was en route to Thurø Rev on board KAREN DANIELSEN, C6SW4, with a draught of 4.6 m, in ballast, on its way to Finland that is just around Vresen and then down south.

Operator 1 acknowledged the report and ended by wishing bon voyage. Operator 1 did not request the air draught of the vessel, because the vessel should not pass under the bridge. Operator 1 "parked" the track of the vessel, because KAREN DANIELSEN was not yet visible on the radar.

Shortly after operator 2 again took over his watch at the operator's desk.

At approximately 1747 hours the echo from KAREN DANILESEN became visible on the radar and operator 2 moved the track of the vessel from the "parking space" to the echo.

According to the watch schedule the team leader should have taken over from operator 2 at the operator's desk at 1800 hours. Around that time he was however occupied by a telephone conversation and he also needed to finalize some administrative work. Therefore he did not take over from operator 2 until approximately 1830 hours.

When he took over operator 2 informed him about the vessels, which were within the VTS area. There were 4 vessels. He was also informed about KAREN DANIELSEN reporting when the ship was off Thurø and the information from the pilot that she was en route to Finland and therefore just to pass around Vresen before going south.

The team leader was well aware of the fact that KAREN DANIELSEN was too large to pass under the bridge.

At that time only the echo of KAREN DANIELSEN was present on the monitor in the area south of the West Bridge, this was a normal picture for the traffic situation. On the radar the vessel steered exactly on a course toward the 3 buoys south of the bridge, where ships normally turn east towards the East Bridge or to proceed south.

It is not possible to tell exactly which route the ships will follow going east. Some will pass north of all 3 buoys while others will cross between the buoys. As the current can run rather strong south off the West Bridge ships will usually cross between the buoys in order to avoid a sharp turn east at a closer distance to the bridge.

After been relieved operator 2 went down to the cellar together with a colleague from the Home Guard, who had arrived at the operation room at about 1800 hours. Below in

the cellar they were to conduct some tests on new VHF equipment belonging to the Home Guard. Operator 2 carried his mobile phone.

From that time and during the rest of the watch period operator 1 was in or close to the operations room and could be called if and when necessary.

Between approximately 1840 and 1900 operator 2 called the operations room three times from the cellar. The team leader answered and operator 2 asked him to “count” on VHF channel 10 to check the VHF equipment, which operator 2 together with his Home Guard colleague were testing.

About 1900 hours the team leader was also occupied by printing out the pilot lists from the Great Belt Pilots and checking them against the VTS database to make sure, that they were ready to be called from the base. This was the normal watch routine and should be finalized before the next team took over the watch.

Operator 1 was then in the nearby pantry dishwashing.

At about 1909 hours the team leader at the operator's desk heard a "Mayday" call. He did not quite understand what was said because the voice calling was exited. He was awaiting Lyngby Radio to respond. The exited voice continued calling "Mayday" and the team leader now understood that the name was KAREN DANIELSEN.

The team leader therefore looked at the radar monitor and he could not see the echo of KAREN DANIELSEN. He then heard that the person calling said that the vessel was locked under the bridge.

The team leader then activated the alarms; to the bridge traffic watch, to the police and to the railway remote control centre.

Immediately after the guard vessel VTS3 was ordered to depart Slipshavn and sail towards the bridge. The echo from KAREN DANIELSEN could still not be seen on the radar monitor; however a small bulge in the bridge could just be made out west of the navigation span.

Operator 2 was called back to the operations room at about 1920 hours.

Some time later the VTS3 advised that they had 6 crew members on board, one of them severely hurt and one with minor injuries.

The boat Y376 also arrived quickly in the area and informed the VTS-Centre that they had taken on board 3 crew members.

4.3 The watch team

VTS Great belt Procedure 002 is about the watch team in the operation centre. It is not stated in the procedure how the watch team organise the duty between themselves.

It was normal practise that only the operator sitting at the operator desk was performing the watch duty when nothing special was going on. An operator should be close by and could be called if more traffic made it necessary. The third operator could relax or work on administration.

VTS Great Belt Procedure 003 is about team leaders and operators and it gives instructions on the watch and duties of the watch team. It is stated that all administrative work and cleaning of the VTS Centre must have been done before the next watch team takes over.

The team leader and the two operators were experienced and had many years of duty at VTS centres.

4.4 Alarm – Danger of collision

VTS Great Belt Procedure 005 – Alarm in case of risk of collision with the West Bridge spanning the Western Channel in Great Belt – see annex 2.

According to the procedure VTS must immediately inform the police, the railway remote control centre in Roskilde and A/S Great Belt traffic watch when VTS estimate, that the navigation of a vessel towards the West Bridge can create a situation of risk to the West Bridge.

If it is estimated that within 10 minutes a vessel will collide with the bridge, VTS activate “alarm”. If VTS estimate that there is a risk that a vessel within 10 to 30 minutes will collide with the bridge, VTS activate “collision warning”.

The “collision warning” or the “alarm” is activated on an alarm panel where the VTS operator activates the relevant buttons and by that activates an audio alarm at the police, the railway remote control centre in Roskilde and A/S Great Belt traffic watch.

After activating the alarms on the alarm panel, the VTS call on dedicated telephone lines and provide information about the alarm.

The alarm panel. Source: VTS’s home page.

The left side of the alarm panel covers the West Bridge and the right side the East Bridge. “Collision warning” is activated by pushing the white and one red button.

“Alarm” is activated by pushing the white and another red button. The green button is for cancellation. The middle white button is for lamp test. The alarm panel for the East bridge has only a button for “alarm”, because “collision warning” here will not normally be relevant. The red lamps flash until the alarm has been acknowledged. On the screen it can be read who has acknowledged the alarm.

The red telephones are the dedicated lines to the police in Slagelse, the railway remote control centre in Roskilde and A/S Great Belt traffic watch.

A/S Great Belt
During the investigators' visit to A/S Great Belt on 1 April the following information was received:

The company Falck is manning the bridge installations and there is 24 hours manning of the operation room, from where one has full sight to the bridge pay installations. There are loudspeakers for information to the road traffic. The watch team consists of a traffic leader and a traffic watch person, their primary task is to secure the road traffic.

In case of a VTS alarm a loud tone is sounded and the reason for the alarm is shown on a monitor, the alarm is acknowledged at the monitor. Close to the monitor is the dedicated telephone. The alarm function and the dedicated telephone are tested every Wednesday.

On 3 March at 1917 hours A/S Great Belt received a phone call from VTS Great Belt. This was followed immediately after by a phone call from the police in Slagelse. At that time the alarm had not been received.

The alarm sounded at 19.17.44 – “collision warning” and “alarm” at the same time.

At 1919 hours the police closed the barriers onto the Great Belt West Bridge.

Railways Denmark – remote control centre in Roskilde
During the investigators' Division's visit at the remote control center in Roskilde on 22 March and from the copy of Railway Denmark's log of the Steering-Regulating- and Overseeing (SRO) - system the following information was received:

The remote control centre is manned 24 hours. Outside normal working hours there are 4 persons on duty. One of the persons on duty (the FC leader) is watching the section from Ringsted to Nyborg, including the bridge.

When the centre receives a bridge alarm it is a high piercing sound and at a monitor a dialog box indicates what is wrong. The alarm is sounded for several conditions (bridge warning, bridge alarm, train break down, wind, water in the tunnel etc.). The alarm is acknowledged by pointing at a string in the dialog box (“kvitter”). Every activity at the SRO-system (Steering-Regulating-Overseeing) is automatically logged.

The FC leader has the responsibility for the safety in relation to the train traffic. He can set all the signals at stop and he can send on emergency stop to individual trains.

The dedicated telephone prescribed in Procedure 005 was not present at the centre.

According to the SRO – log the alarm for warning of possible collision and the collision alarm was received at 191744 hours.

The train traffic was stopped immediately after – at that time there were no trains on the West Bridge.

At 004950 hours the train traffic was re-opened.

Subsequent Railways Denmark has informed the Investigation Division in writing, that a special ”red” telephone apparatus did not exist at the remote control centre in Roskilde. However, at all times there has been a dedicated telephone line.

Following the collision all relevant telephone lines at the remote control centre have been checked and a few minor alterations have been carried out. The telephone display will now clearly indicate when the activation is due to a VTS alarm, when the VTS-centre uses the dedicated telephone line.

The Police in Slagelse
The police received a telephone report about the collision at 1917 and immediately followed by “collision warning” and “alarm”.

The road traffic was closed at 1919 and police patrols were dispatched to the bridge from both Korsør and Nyborg to stop the traffic and to “empty” the bridge of cars before lowering the barriers.

4.5 Communication etc.

From VTS Great Belt the investigators have received a recording of communication on VHF, channel 11 and channel 16, and also written analyses of the radar log of the VTS Centre in the time period 160527 to 182744 (UTC).

From VTS Great Belt the investigators have also received a recording of the radar pictures from 1600 to 1900 hours (UTC).

At Lyngby Radio the investigators have overheard the logging of the VHF channel 16 communications between 1730 and 1901 (UTC) hours.

The VHF channel 16 communications from VTS Great Belt and from Lyngby Radio are identical. However, there is a difference in time of about 3½ minutes – the VTS logging is 3½ minutes earlier than the logging from Lyngby Radio.

In the following framework are listed those communications and those radar observations etc., which are found relevant for the investigation. All times are Danish local time (UTC + 1) and the times are the loggings from VTS Great Belt. Abbreviations: KD – KAREN DANIELSEN. LYRA – Lyngby Radio.

Hours (local time)	**Duration**	**Transmitter/ VTS Radar**	**Subject**
17.05.27	0.45	Possible pilot on KD – VHF	Blurred call
		VTS – VHF	*”Dette er VTS Storebælt, er der nogen der kalder”*

Hours (local time)	Duration	Transmitter/ VTS Radar	Subject
		KD – VHF	*"Det er Svendborg lods jeg er på vej ud på revet med et skib der hedder Karen Danielsen, C6SW4, 4,6 i ballast til Finland så han går lige op og runder Vresen så går han ned igen"*
		VTS – VHF	*"Tak og det var Karen Danielsen der skulle til Finland og 4,6 lige rundt Hov eller Spodsbjerg til Langeland tak skal du have og god tur"*
		KD – VHF	*"Tak"*
17.47.15		VTS Radar	Track is moved from the parking place at Langeland to KD
18.37.43		VTS Radar	Cursor moved to the echo of KD - 55°12,28' N - 10°52,13' E
18.55.00		VTS Radar	KD passing telecabel – 55°15,88' N - 10°51,71' E
18.58.21		VTS Radar	KD's 10 min. vector touch the West Bridge
19.01.24	0.24	VTS intern.	Intern VHF test (1-2-3-4)
19.01.37	0.23	VTS intern.	Intern VHF test (1-2-3-4)
19.02.00		VTS Radar	KD off the shallow water off Knudshoved
19.07.10		VTS Radar	KD's echo touch the West Bridge
19.08.56	0.42	KD – VHF	*"Mayday Mayday Karen Danielsen (are repeated several times) – we are under the bridge somebody hear"*
19.09.44	2.41	KD – VHF	*"Mayday Karen Danielsen (are repeated)"*
		VTS – VHF	*"Karen Danielsen this is Great Belt Traffic we hear your Mayday you are sitting under the bridge"*
		KD – VHF	*"Mayday Karen Danielsen somebody hear you (are repeated)"*
		VTS – VHF	*"Karen Danielsen this is Great Belt Traffic we hear your message is there any danger"*
		KD – VHF	*"Mayday Mayday this is Karen Danielsen motor vessel Karen Danielsen we are sitting under the bridge we are on the bridge – bridge"*
		VTS – VHF	*"We are sending a vessel"*
		KD – VHF	*"We need we need help we need assistance"*
		VTS – VHF	*"Yes we understand you need assistance"*
		LYRA – VHF	*"Her er Lyngby Radio hvad er der galt ved Karen Danielsen"*
		KD – VHF	*"Karen Danielsen calling C6SW4 over"*
		VTS (answer to LYRA) – VHF	*"Han er åbenbart kommet i klemme under Vestbroen han skulle slet ikke op under broen vi forstår ikke rigtig hvad han har lavet"*
		KD – VHF	*"Mayday Karen Danielsen C6SW4 over"*
		VTS – VHF	*"Karen Danielsen this is Great Belt Traffic we hear your message we are aware of the situation that you are lying under the bridge"*
		KD – VHF	*"Is correct ……we have hit the bridge over"*
		VTS – VHF	*"You have hit the bridge yes we understand and please try to be calm"*
		KD – VHF	*"I cannot hear you very I'm talking with a walkie*

Hours (local time)	Duration	Transmitter/ VTS Radar	Subject
			talkie I don't hear you"
		VTS – VHF	*"Yes is there any danger to the bridge or only to the ship"*
19.13.45	0.40	VTS to A/S Great belt – telephone	*"Ja det er fra Storebælt Trafik vi skal have lukket for broen for der er et skib der er i klemme under Vestbroen – vi …. give forvarsel - OK det er godt ja – hej"*
		A/S Great Belt – telephone	*"Ja det er Peter"*
		VTS – telephone	*"Ja det er Storebælt Trafik vi skal have lukket Vestbroen for der er et skib der er gået i klemme derinde under på en eller anden måde"*
		A/S Great Belt – telephone	*"Det er i orden"*
		VTS – telephone	*"OK og politiet er varskoet"*
		A/S Great Belt – telephone	*"Ja det er fint godt hej"*
19.13.48	0.20	KD – VHF	*"Please Mayday Mayday Karen Danielsen Karen Danielsen did somebody see us"*
19.13.50	0.22	VTS to police – telephone	*"Ja det er fra Storebælt Trafik vi skal have lukket broen der er et skib der er gået I klemme under broen – under Vestbroen – OK – så vi giver et forvarsel – (svar svagt) OK – Vi lukker med det samme – det er godt ja – hej – hej"*
19.14.41	0.16	LYRA - VHF	*"Karen Danielsen Karen Danielsen Mayday Karen Danielsen this is Lyngby Radio come in please"*
19.15.59	0.12	VTS - VHF	*"Karen Danielsen Karen Danielsen Great Belt Traffic"*
19.16.12	0.38	VTS – VHF	*"Karen Danielsen Karen Danielsen Great Belt Traffic"*
		KD – VHF	*"Yes Karen Danielsen is listening"*
		VTS - VHF	*"Karen Danielsen is anybody hurt do you have any people who is hurt"*
		KD – VHF	*"Yes someone is missing from the bridge the bridge is completely broken and one man is missing the captain is hurt"*
		VTS - VHF	*"OK we have a ship coming to you we have a ship coming to you now"*
		KD – VHF	*"OK thank you very much"*
19.21.23	0.26	VTS to Railways DK - telephone	*"Ja det er nede fra VTS Storebælt – dav – der har været en påsejling af Vestbroen –ja – det er derfor alarmen er der – ja det ved vi – ok – vi har fået meldingen nede fra SROC – ok – det er alle tiders – yes – det er i orden – ok – tak skal du have – hej – hej"*

Hours (local time)	Duration	Transmitter/ VTS Radar	Subject
19.23.49	0.23	KD – VHF	*"Mayday Mayday Mayday this is motorvessel Karen Danielsen we hit the bridge on the bridge and now we have fire onboard"*
19.25.41	0.24	LYRA - VHF	*"Mayday Karen Danielsen this is Lyngby Radio do you hear me"*
19.25.50	1.24	VTS to police – telephone	About fire on board.
19.26.14	0.31	LYRA - VHF	*"Mayday Karen Danielsen this is Lyngby Radio. We have understand that you have fire onboard. Please tell us how many persons are there onboard and are any of them injured over"*
		KD – VHF	*"I don't hera you very well I don't hear you very well please Lyngby Radio Lyngby Radio Karen Danielsen"*
		LYRA - VHF	*"Yes how many person onboard. Karen Danielsen please tell how many persons onboard"*

4.6 Technical alarm function on the VTS system

There are several automatic alarm functions in the VTS system. E.g. it is possible to insert a zone on each side of the bridge. Echos from vessels within the zone will activate the alarm.

The automatic alarm function has not been used for the last 8 years. According to the Admiral Danish Fleet (SOK) Great Belt the reason for not using the alarm function is that if used it had to be linked to the 10 minutes warning alarm and that the zone thus would be so great that the alarm would be activated constantly due to ships which were not a risk to the bridge, e.g. ships navigating parallel to the bridge en route Nyborg and several cases where ships were en route Svendborg or Rudkøbing.

According to SOK the system was never approved by SOK partly because the alarm function of the system was not suitable.

According to SOK the system is being modernised and that the modernized system is expected to be in use by December 2005. An improved automatic alarm functions will be part of the modernized system.

4.7 Recommended track south of the West Bridge

In BA chart No 938 (Danish chart no 143) is a recommended track between E-lige and W-lige Puller for ships with a draught of max. 8 metres. Ships navigating north of W-lige Puller are recommended to proceed with moderate speed and as far as possible not higher that 7 knots.

It is quite normal, that northbound ships are navigating between the buoys or north of the W-lige Puller buoy when going east for passage of the East Bridge or for a southbound passage in the Great Belt.

When following the recommended track the West Bridge is passed at a distance of 1.8 miles.

4.8 Fatigue

The team leader on duty at the operator's desk at the time of the collision, has told the investigators that he had concerns in relation to his work. These concerns had increased the day before the accident, because of an incident and because of this he had felt rather worried. He had felt uncertain on how to handle his worries and he had tried to get some advice from an acquaintance, who knew the Navy and VTS system. However, he had not been able to contact the said person until he called on the 3rd March around 1800 hours and it was this telephone call lasting about ½ an hour, which had delayed him taking over the watch at the operator's desk late, at about 1830 hours.

After the telephone conversation the concerns he had and the conversation were playing on his mind, the team leader thinks this, the administrative work with pilot lists and the radio check have been essential contributory factors to his failing concentration and the fact that he did not notice that the echo of KAREN DANIELSEN continued on an unchanged course towards the bridge.

The team leader is also of the opinion that the colours on the radar screen are not suitable. Land contours and shallow water areas are in sharp colours while echoes and vectors are in weaker colours. He is of the opinion that the sharp colours are automatically caught by the eye and that it is therefore more difficult for the operator to register the changes of the weaker coloured echoes and vectors, especially after a longer period in front of the radar screen.

The team leader advised that he uses to change the colours on the radar screen, but he had not changed the screen at the time of the accident. The team leader also advised, that the strong colours on the screen had been addressed to the VTS management and the "Bedriftsundstjenesten", but that there has been no examination on whether it is a real problem.

The head of VTS Great Belt has told the investigators, that it is possible to use screen adjustments decided by the user. He also advised that the screen adjustments have been discussed at meetings at the VTS Centre. Because it is fast and easy to adjust the screen, they had agreed that each operator should choose the adjustments he or she preferred.

5 Analyses

5.1 Navigation

The chief officer did not initiate a turn to the east at waypoint 107, as he should have done according to the passage plan. Waypoint 107 was passed at 1857 hours.

From the course alteration at waypoint 106 at 1820 hours to the collision at 1907 hours, the ship maintained the same course 005° and speed 11,5 knots.

The GPS Navigator had been sounding on the bridge from the time the ship passed waypoint 107 at 1857 hours and until the collision at 1907 hours.

The chief officer was found to have been sitting in the port side bridge consul chair in the wheelhouse, when the accident occurred.

The chief officer was killed in the collision.

The available evidence suggests that the chief officer had fallen asleep, some time after the alternation of course which he made at 1820 hours to 005°.

5.2 Alcohol

At the post mortem examination, the alcohol test proved that the chief officer had an alcohol concentration in the blood of at least 1.55 0/00.

Neither the master nor other crewmembers saw any sign indicating that the chief officer was under the influence of alcohol prior to the accident.

According to the ISM-manual it was forbidden to consume alcohol during duty and watch periods. It was not allowed to reach per mille higher than 0.4 0/00.

The chief officer had consumed alcohol more than three times in excess of the Company's ISM permitted maximum and violated the instructions on alcohol in the ISM-manual.

5.3 Look-out / watch keeping

The chief officer was alone on the bridge from approx. 1815 hours, when he took over the watch from the Master until the collision at approx.1907 hours.

The master did not instruct the chief officer to have a look-out in the wheelhouse, before the master left the wheelhouse at approx. 1815 hours.

The master was on his way to the wheelhouse when the collision occurred.

On 3 March 2005, the sunset was at 1755 hours at the location of the collision.

According to the STCW Code, the officer in charge of the navigational watch may be the sole look-out in daylight provided on each such occasion the situation has been carefully assessed and it has been established without doubt that it is safe to do so.

It is neither stated in the ISM-manual nor in the master’s standing order that there must be a look out on the bridge when it is not daylight.

According to the master and the AB, who have been on board since 3 December 2004, the deck crew worked as day men from 0800 to 1700 hours. The deck crew only worked as look-outs on the bridge under exceptional circumstances.

It was stated in the ISM-manual that it should be noted in the deck logbook with the seaman's name, if one of the deck crewmembers had been on duty as look-out.

In the deck logbook, (*Chief officer's log book)* it is stated with name and watch period, that deck crewmembers were working as look-out 24 hours a day, when the ship was at sea.

If a look-out had been on the bridge, the accident would probably have been prevented, because the look-out would have heard the GPS alarm, observed the bridge and realised that the chief officer was probably asleep.

Because the accident took place more than an hour after sunset, it was no longer daylight and there should have been a look-out on the bridge.

The master should before he left the bridge have ordered a look-out to the bridge.

It should be stated in the ISM-manual and the master's standing order, that there should be a look-out on the bridge, when it is not daylight.

It has apparently been the practise on board, that there was only a look-out on the bridge under special circumstances. This is not in adherence to the STCW Code; there should be a look-out on the bridge, when it is not daylight.

The information in the logbook, stating that there has been a look-out on the bridge 24 hours a day when at sea, was not correct. From the evidence gathered, the seamen have apparently been on call, but were not necessarily present in the wheelhouse keeping a look-out during these periods.

5.4 Bridge watch alarm

A bridge watch (dead man) alarm was installed in the wheelhouse on the KAREN DANIELSEN.

When the master left the bridge at approx. 1815 hours, the bridge watch alarm was not in use. He did not order the chief officer to use the bridge watch alarm.

There were no rules for using the bridge watch alarm in the ISM-manual.

There is no international regulation for the installation of bridge watch alarms on ships.

Use of the bridge watch alarm would probably have prevented the accident, because the alarm would have started the general alarm and thereby indicating, that something was wrong on the bridge.

There should have been rules for use of the bridge watch alarm in the ISM-manual.

GPS waypoint alarm
The GPS alarm had been sounding on the bridge from 1857 hours and until the collision at 1907 hours. When passing a waypoint the GPS starts to "beep", however this is only a low volume alert or warning.

5.5 Working/resting hours

The chief officer was off duty from 2 March late in the afternoon, until the following morning, on the 3 March, the day of the accident.

On 3 March the chief officer worked from the morning and the only breaks he had were the meal breaks. At 1815 hours he took over the watch on the bridge and he was on watch until the collision occurred at 1907 hours.

Within the watch rota it was scheduled that the chief officer should have been on watch until 2200 hours and again from 0400 to 1000 next day.

The chief officer had been working more than 11 hours when the accident occurred, with only meal breaks.

The working hours of the chief officer should have been planned in such a way, that he had more rest during the day, before taking over the first sea watch. There was insufficient priority given to the rest periods of the watch keeping crew, during what was a very busy port schedule.

5.6 ISM audit

The ISM audit after the accident identified two non-conformities, both of which were related to the accident:

1. The use of bridge watch (dead man) alarm was not included.
2. There was a discrepancy over the employment of the crew.

Further;

The instructions in the ISM-manual regarding the bridge watch-keeping arrangements did not correspond with the requirements of the STCW Code with respect to keeping a look-out during hours of darkness. This non-conformity should have been identified by the Classification societies at the ISM audits before and after the accident.

6 Analyses – VTS Great Belt

6.1 The Watch Team

The VTS Great Belt procedures did not include rules on the watch team's internal organisation.

The watch had been organised according to regular practise. In the period prior to the collision, only a few ships were in the VTS area. It was not until 10 minutes prior to the collision that something out of the ordinary happened, which should have made the watch team leader at the operators desk call for the operator in the kitchen or the operator in the basement for assistance.

The fact that the surveillance of the VTS area had been left with only one operator contributed greatly to KAREN DANIELSEN's steady course going unobserved and why an alarm for danger of collision was not initiated 10 minutes prior to the collision

occurring. It also prevented the VTS-centre from trying to contact KAREN DANIELSEN and warn that the vessel was standing into danger.

According to the Admiral Danish Fleet, the internal watch procedure has been changed to the effect that there are now always two operators in the immediate vicinity with the operator's desk. One of them is primarily responsible for communication and the other one is primarily responsible for watching the radar screens.

Plotting
At 1747 hours, KAREN DANIELSEN could be seen on the VTS-centre's radar. The ship's track, which, following the reporting by the pilot, had been "parked", was now moved to the echo of KAREN DANIELSEN.

In VTS Great Belt' procedure 004 on plotting and identification, it says: " In areas with poor radar coverage (The waters between Langeland and Fyn, Romsø and Fyns Hoved together with Omø- and Agersøsund, ports etc.,) careful attention has to be paid. Report to be received, track to be parked and the ship to be requested to report in at a given point or at a later time, so that the "parked" track can be moved to the right radar plot when safe identification has been achieved."

At no time was the VTS-centre in doubt as to the identity of KAREN DANIELSEN. The pilot' report had been received, there were no other echoes on the screen that could be confused with that of KAREN DANIELSEN, and the AIS information was also available.

Therefore, the VTS-centre did not request KAREN DANIELSEN to report in at a given point within the radar coverage and the centre did not call the ship after the ship had appeared on the radar screen.

Irrespective of the fact that the VTS-centre had no doubt about KAREN DANIELSEN's identity on the radar screen, the investigators were of the opinion that, that by omitting to request the ship to report and by omitting to call the ship, the centre cut off themselves from direct contact with KAREN DANIELSEN's master or the officer on watch and hereby the positive effect such contact could have had to get the attention of the person on watch.

6.2 Communication and alarm
The times that VTS Great Belt has stated, regarding the communication on VHF, channel 16 and the time table under chapter 4.5 are 3-½ minute earlier than the times stated by Lyngby Radio.

According to the time table, the VTS operator was in contact with the A/S Storebælt (Great Belt line) and the police in Slagelse on the dedicated phone line almost simultaneously at 1914 hours.

According to A/S Storebælt, A/S Storebælt received a phone call from VTS Great Belt, shortly before the alarm sounded at 19:17:44 hours, informing them about the collision, ref. chapter 4.4.

According to the police in Slagelse, the Police received information by phone about the collision at 1917 hours and immediately after, the alarm indicating collision sounded, ref. chapter 4.4.

According to Banedanmark (Danish Rails), the remote control unit in Roskilde, the alarm indicating collision sounded at 19:17:44, ref. chapter 4.4.

Operators from the VTS-centre have informed investigators that, once a week (on Wednesdays), they conduct a time check of the centre's various systems by comparing the time with the centre's main clock. Each system has to be adjusted separately and according to the operators, it is rather complex process to get the clocks synchronised.

Therefore, the accident investigators are of the opinion that the times indicated by VTS Great Belt are 3-½ minutes earlier than the correct time. Furthermore, that the times indications of the radar recordings are correct, because they correspond with the AIS information.

Therefore, it can be ascertained that the collision occurred at 1907 hours, that the VTS-centre became aware of the collision at approximately 1913 hours, that the VTS-operator contacted A/S Storebælt and the Police at approximately 1917 hours, that the VTS-centre initiated the alarm (and the warning) indicating collision at 19:17:44, and that the VTS-centre contacted Banedanmark (Danish Rails) by telephone at approximately 1925 hours.

Communication language
At 1706 hours VTS Great Belt communicated with the pilot on KAREN DANIELSEN. The communication was in Danish.

According to VTS Great Belt's procedure on watch keeping in the operation room, the communication language is Danish and English, thus when in contact with Danish ships, Danish language is used and when in contact with foreign ships, English language is used. There is a reference to the IMO's Standard Marine Communication Vocabulary.

In this case, by communicating in Danish with the pilot, they prevented the master and/or the officer on watch on board KAREN DANIELSEN from keeping abreast with the communications. The investigators could not ascertain that this had a direct impact on the circumstances leading to the collision. However, the investigation of previous accidents has identified it to be a safety hazard, when a pilot on a foreign ship communicates in the Danish language.

6.3 Technical alarm system of the VTS system

There is no suitable automatic alarm function in the VTS surveillance system. The investigators were of the opinion that this prevented the inattentive operator on duty from being warned about the danger of collision with the bridge.

It is noted that the VTS internal watch procedure have been changed, to the effect that there are now always two operators in attendance at the control consoles.

Furthermore, the information received from the Admiral Danish Fleet regarding a new updated VTS system with an improved automatic alarm function, will be implemented in the near future.

6.4 Recommended track south of the west bridge

The recommended track passes the West Bridge at a distance of 1.8 nautical miles when the track is closest to the bridge.

The main task of the VTS Great Belt is to initiate the alarm within 10 minutes if there is danger of collision with the bridge.

In this case, where KAREN DANIELSEN was proceeding at a speed of 11.5 knot, the sailing time from the recommended track to the bridge was only 9-½ minutes.

If, contrary to expectation, a ship does not alter course onto the recommended track and proceeds towards the bridge at a speed of more than 10 knots, it will not be possible to initiate the alarm 10 minutes in advance of a possible collision.

6.5 Fatique

The watch team leader had concerns about his work and he communicated on the telephone about these concerns for about half an hour just before he took over the watch at the operator's desk.

In the critical time period between approximately 1850 hours and the time of the collision, he was busy making ready for the watch relief at 2000 hours and he also participated in an internal test of the VHF equipment.

The investigators were of the opinion that the watch team leader’s worries had the effect that he could not maintain his normal standard as operator on duty. His worries also explain his limited ability to register the unexpected and the out-of-the-ordinary situation that arose when KAREN DANIELSEN did not make the planned course alteration, as previously advised by the pilot.

Furthermore, the investigators were of the opinion that it is wrong for the operator on duty, whose main responsibility is to monitor the radar screen, to do paper work during the watch.

Also in this connection, it is noted that the VTS-centre has changed the internal watch procedure, so that there are always have two operators in attendance at the control consoles.

6.6 The possibility for the VTS-centre to prevent the collision

In order to prevent the collision, the VTS-centre should have followed KAREN DANIELSEN on the radar and realised that the ship was not turning as expected.

Ordinarily, ships proceed between the three buoys south of the bridge when en route from Svendborg and heading towards the East Bridge or southward towards the Baltic Sea. Some ships pass north of the buoys. A recommended track between the E-lige and W-lige Puller has been marked in the chart, this track runs 1.8 nautical miles from the West Bridge, at the nearest point.

If the VTS-centre had followed KAREN DANIELSEN on the radar, the centre would only have had reason to assume that something was wrong approximately 9-½ minutes before the collision occurred because the ship did not turn east. The VTS-centre could have:

- called KAREN DANIELSEN on the VHF
- sent out the guard vessel from Slipshavn

The chief officer on KAREN DANIELSEN was alone on the bridge. It is not possible to determine whether he would have heard a call on the VHF. He did not hear the “line alarm” from the GPS navigation which sounded for about 10 minutes.

It would have taken approximately 10 minutes from the VTS-centre’s alarm to the guard vessel in Sliphavn for the vessel to get close to KAREN DANIELSEN. This would have been too late in this case. The guard vessel could have tried to get the attention of the crewmembers on watch or to get the attention of other crewmembers by using its searchlight, loudspeakers or other sound signals.

Even if the VTS operator had realised that KAREN DANIELSEN was not turning east, it is doubtful whether it would have made any difference to the collision.

The Admiral Danish Fleet has stated that they, as a consequence of the accident, have established the following special procedures for ships that are navigating from Svendborg into the VTS area:

- Svendborg Port informs VTS Great Belt by fax when a ship departs
- The VTS-centre calls the ships 5-10 minutes before they reach the turning point and asks them to confirm their intention to alter course.

7 Conclusion

KAREN DANIELSEN

KAREN DANIELSEN had a collision with the Great Belt West Bridge, because a turn to the east at waypoint No.107 was not initiated as planned.

The following factors contributed to the collision:

- The chief officer probably fell asleep between 1820 and 1857 hours.

- It has been established that the chief officer was influenced by alcohol prior to the collision. At the post mortem examination, the alcohol test proved that the chief officer had an alcohol concentration in the blood of at least 1.55 0/00, more than three times the ISM permitted limit.

- The chief officer was alone on the bridge from 1815 hours until the collision.

- Because the accident took place more than an hour after sunset, it was no longer daylight and there should have been a look-out on the bridge.

- It was not stated in the ISM-manual for the ship or in the master's standing orders, that there should have been a look-out on the bridge when it was not daylight.

- A bridge watch (dead man) alarm was installed on the bridge of KAREN DANIELSEN, but the alarm was not in use when the master left the bridge at 1815 hours.

- The chief officer had been on duty more than 11 hours when the accident occurred. The only breaks he had were meal breaks.

VTS Great Belt
The main responsibility of the VTS Great Belt is to initiate the alarm for a possible collision with the Great Belt Bridge, when it is estimated that a collision may occur within 10 minutes.

KAREN DANIELSEN collided with the bridge at 1907 hours. VTS Great Belt became aware of the collision at approximately 1913 hours. The VTS Great Belt initiated the alarm at 1917 hours.

Thereby, the VTS Great Belt did not fulfil its main responsibility because the operator on duty did not realise that KAREN DANIELSEN had not made the expected course alteration, but continued on a steady course towards the bridge.

The investigators were of the opinion that the following circumstances contributed to the fact that VTS Great Belt did not realise KAREN DANIELSEN's course remained unaltered:

- There was only one operator at the control consul desk and therefore there was no back up.
- The operator on duty's private worries reduced his ability to maintain an efficient watch.
- The operator on duty's paper work distracted his attention from watching the radar screens.
- There was no suitable automatic alarm function in the VTS surveillance system.

The VTS Great Belt did not contact KAREN DANIELSEN after the ship had entered the radar coverage area.

It is doubtful whether VTS could have avoided the collision even if the operator on duty had realised that KAREN DANIELSEN was not turning east.

The distance from the recommended track south of the West Bridge is too short for the alarm to be initiated 10 minutes before a possible collision.

8 Recommendations and initiatives

8.1 Bridge watch alarms

The investigation of KAREN DANIELSEN's collision with the Great Belt West Bridge has concluded that the use of the bridge watch (dead man) alarm would probably have prevented the accident.

After the accident, the Danish Maritime Authority has in IMO requested a worldwide demand for bridge watch alarms on ships.

Following this accident, it is recommended that the Bahamas Maritime Authority and the Danish Maritime Authority submit a joint paper to IMO to propose the adoption of mandatory fitting and use of bridge watch alarm systems on ships.

8.2 ISM

Look-out
The ship's ISM-manual did not include instructions to the effect that there has to be a look-out on the bridge when it is not daylight.

It is recommended, that Nordane Shipping correct the ISM-manuals, so that it corresponds with the STCW Code.

It is recommended, that the Classification societies during ISM audits confirm the instructions regarding look-out correspond with the requirements of the STCW Code.

Bridge watch (dead man) alarm
The investigation revealed that KAREN DANIELSEN's ISM-manual did not include instructions with respect to the use of the bridge watch alarm.

It is recommended that Nordane Shipping correct their ISM-manuals to include guidelines for the use of the bridge watch alarm.

Rest periods
It is recommended that Nordane Shipping update their ISM procedures to ensure that watch keepers are adequately rested prior to going on duty. Watch keepers rest periods must be prioritised within a vessels work schedule.

Crew relief procedures
It is recommended that Nordane Shipping and the owners review and confirm to the Bahamas Maritime Authority their crew relief procedures, to ensure that crew members joining a vessel and expected to go straight on duty are adequately rested.

8.3 VTS Great Belt

Watch keeping
The Admiral Danish Fleet is recommended to review the procedures for watch keeping at the VTS-centre so that the VTS-centre's surveillance of the VTS area will work safely under all circumstances and that the VTS-centre will always be able to initiate the

alarm for a possible collision with the Great Belt Bridge no later than 10 minutes prior to a possible collision.

It has been reported that the Admiral Danish Fleet has already launched the following initiatives:

- The VTS-centre's internal watch procedure have been changed to the effect that two operators are always ready in the immediate proximity of the operator's control consul. One of them is primarily responsible for communication and the other one is primarily responsible for the watching the radar screen.
- Svendborg Port must inform VTS Great Belt when a ship departs.
- The VTS-centre has changed procedure 005, part 5 as follows:

Procedure 005, part 5:
For navigating to/from Nyborg and through the waters between Fyn and Langeland a recommended track has been established. The track is positioned more than 10 minutes sailing time (at 10 knots) from the West Bridge. Ships en route to/from Nyborg and in the waters between Fyn and Langeland must be informed about the recommendation and must report their intentions when they transmit their regular report to VTS Great Belt. Ships must be requested to report to VTS Great Belt when passing the following reporting-lines:

55°15' N – when proceeding north
10°50' E – when proceeding east
11°00' E – when proceeding west

In the case when the ship does not report, VTS Great Belt must contact the ship for verification of its intentions as previously reported.
Ships intending to use a track between the recommended track and the West Bridge must be informed that they should proceed at a moderate speed, as far as possible not exceeding 7 knots and also about the consequences of exceeding the 7 knots speed limit. If this speed limit is exceeded, alarm must be initiated, cf. part 10 and 11.

The VTS-system's automatic alarm function
The Admiral Danish Fleet is recommended, in the VTS surveillance system, to implement an automatic alarm function which is activated if a ship that could constitute a hazard to the bridge unintentionally approaches the bridge at a distance of less than 10 minutes sailing time.

The Admiral Danish Fleet's advice on the updated surveillance system that they expect to be ready for operation December 2005 is noted. The updated system includes improved automatic alarm functions.

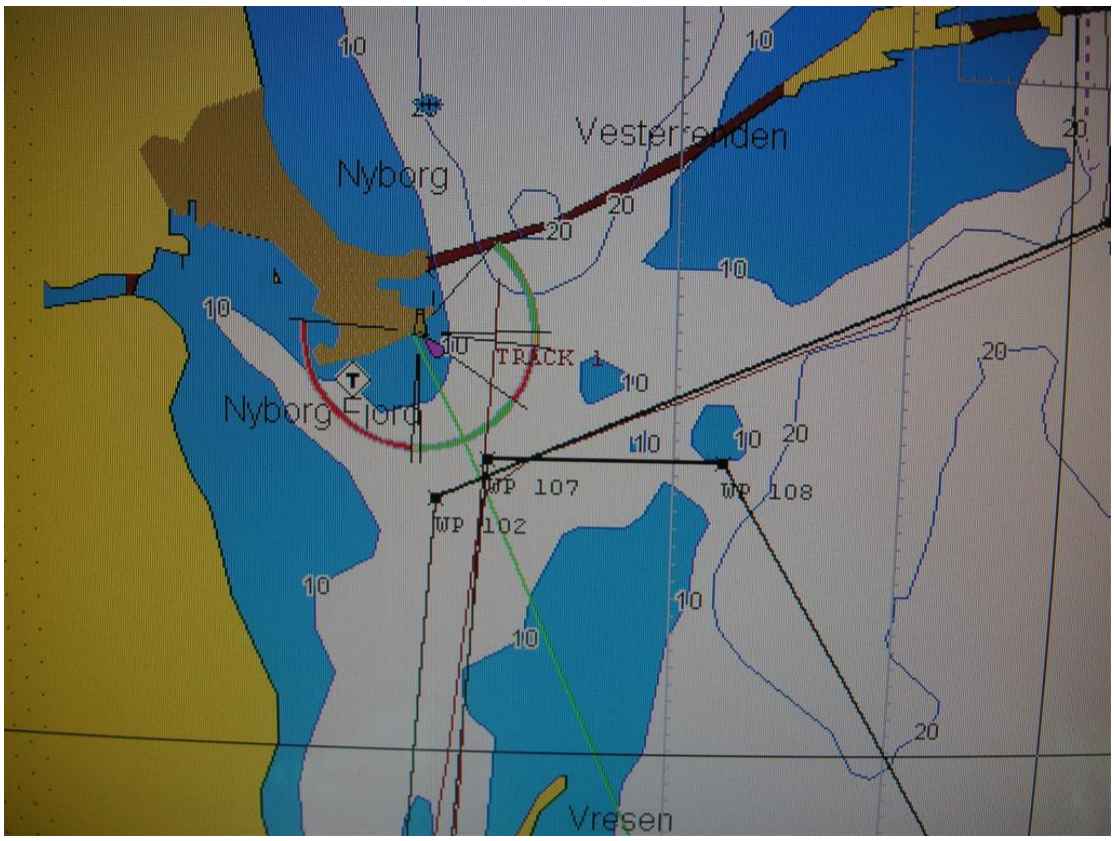
The recommended track south of the West Bridge
It is recommended that the Admiral Danish Fleet, together with the Royal Danish Administration of Navigation and Hydrography move the currently recommended track further to the south or to enlarge the area surrounding the bridge where a maximum speed of 7 knots is required. This would enable VTS Great Belt to initiate an alarm for possible collision with the West Bridge at least 10 minutes before a collision occurs.

9 Enclosures

Enclosure 1: Data from GPS

Data from the KAREN DANIELSEN's GPS navigator were transferred to an electronic chart on a SIMRAD CA44 with colour display.

The photos show the KAREN DANIELSEN's passage plan and actual track recorded on the ship's GPS Navigator – entering and leaving Svendborg.



The photos show the area south of the Great Belt Bridge. The red line "TRACK 1" shows the ships actual track before the accident. The track is historical information stored in the system. The track stops shortly before the bridge (0,22 nm) due to the periodic updating of the system.

The inbound passage plan through the Great belt to Svendborg is also shown, via WP 102. The outbound passage plan from Svendborg is via WP 107 and WP 108.

Enclosure 2: Procedure 005 from VTS Great Belt in Danish as it was at the time of the accident. (The procedure has been amended after the accident).

VTS Storebælt

Procedure 005

Alarmering ved fare for påsejling af Vestbroen over Vesterrenden i Storebælt.

FORMÅL

1. Formålet med denne procedure er at fastlægge retningslinier og kommandoveje for koordinering og udveksling af vitale informationer om skibstrafikken omkring Vestbroen til sikring af motorvejs- og jernbanetrafikken.

GENERELT

2. I forbindelse med etableringen af den faste forbindelse over Storebælt er det besluttet at oprette et "Vessel Traffic Service" (VTS) system i området. VTS-systemet skal virke til generel sikring af den faste forbindelse og havmiljøet i VTS området ved vejledning, kontrol og eventuel assistere skibsfarten ved gennemsejling af broen over Østerrenden eller Vesterrenden, herunder tilgodese krav til specielt Vestbroens sikkerhed.

3. Driftsorganisationen for VTS systemet (VTS Storebælt), driftsorganisationerne for henholdsvis baneforbindelsen (Banestyrelsen) og Vejforbindelsen (A/S Storebælt) er ved A/S Storebæltsforbindelsens bestyrelses brev af 17 JAN 1991 [01], pålagt at sikre det nødvendige samspil mellem overvågningssystemerne for skibs-, jernbane- og motorvejstrafikken, herunder at udarbejde koordinerede nødplaner i tilfælde af større uheld, der berører flere af trafikanterne. Det skal således sikres, at al trafik (jernbane- og motorvejstrafik) på Storebæltsforbindelsen stoppes, hvis der skulle opstå en overhængende fare for påsejling af Vestbroen.

VESTBROEN

4. Vestbroens piller har en kapacitet til at modstå en påsejling svarende til et skib på 2.000 tons dødvægt (DWT) og en fart på 14 knob. Sejlads gennem Vestbroen er kun tilladt for skibe under 1.000 DWT. Der er etableret afmærkning af to gennemsejlingsfag til hver sejlretning, og med en frihøjde ved normal vandstand på 18 meter i en bredde på 80 meter omkring midten af brofaget jævnfør bilag 1. Gennemsejlingsfagene har en fri bredde på 104 meter. Skibe på 1.000 DWT og derover er henvist til at bruge trafikseparingen i Østerrenden.
Under uheldige omstændigheder:

a) kan overbygningen på et skib af størrelsen 300 - 999 DWT ødelægge brodrageren på den lave del af broen. Den lave del af broen er fra østlige landfæste til og med pille 13 og fra vestlige landfæste til og med pille 55. (se bilag1)
b) vil kollision med en meget høj mast mod brodrageren kunne være til fare for trafikanterne. Det kan ske, hvis masten er så høj, at en del af masten ved kollisionen kan falde ned på brodrageren. Især på jernbanedrageren kan dette være farligt, idet et tog, der rammer mastedelen, kunne blive afsporet. Ved gennemsejlingsfaget skal mastehøjden være mindst 26m for at kunne være farlig. Ved landfæster kan en mastehøjde på 18m være farlig.

c) Kan kollision mod broen af et skib med farligt gods medføre udslip af lasten til fare for trafikanterne enten direkte, eller fordi broen vil kunne blive skadet af eksplosion eller brand.

5. I forbindelse med sejlads til/fra Nyborg er der etableret en anbefalet sejlrute der ligger mere end 10 minutters sejlads væk fra Vestbroen. Skibe på vej/til Nyborg skal orienteres om denne anbefaling. Hvis skibe i ovennævnte kategori ønsker at benytte en sejlrute mellem den anbefalede sejlrute og Vestbroen, skal de underrettes om, at dette bør ske med moderat fart, så vidt muligt maksimalt 7 knob, og om konsekvenserne ved overskridelse af 7 knob. Hvis denne fart overskrides skal der alarmeres jævnfør punkt 10 og 11.

6. Procedure for alarmering af Vestbroen over Vesterrenden i Storebælt ved fare for påsejling fremgår af punkt 10.

7. For Østbroens vedkommende skal der henvises til Procedure 006 for alarmering ved fare for påsejling af Østbroen i Storebælt og ved påsejling af broens pyloner.

DRIFTSORGANISATIONERNE

8. Trafikken over og omkring Storebæltsforbindelsen kontrolleres af følgende trafikdriftsorganisationer:

a. A/S Storebælt.
Motorvejstrafikken kontrolleres fra Storebælts Trafikvagt der ligger ved betalingsanlægget i Halsskov. Herfra kan A/S Storebælt overvåge trafikken og kan om nødvendigt, sammen med politiet, spærre for trafikken.

b. Banestyrelsen (Fjernstyringscentralen i Roskilde).
Jernbanetrafikken gennem tunnel- og på brostrækningen overvåges og styres fra fjernstyringscentralen i Roskilde. Herfra er man forbundet direkte til et styrings- regulerings- og overvågningsanlæg (SRO), som overvåger de tekniske anlægsfunktioner på jernbaneforbindelsen.

c. VTS Storebælt.
Skibstrafikken overvåges fra VTS Storebælt beliggende på Flådestation Korsør. Det vil være herfra en opstået fare for påsejling af Vestbroen først vil kunne erkendes.

d. Politiet (Alarmeringscentralen Slagelse).
A/S Storebælt og VTS Storebælt underretter pr. telefon eller SRO anlæg politiets alarmeringscentral i Slagelse. Banestyrelsen (Fjernstyringscentralen i Roskilde) underretter dog kun i tilfælde af togulykke. Herfra koordineres politiets opgaver vedrørende styring, regulering og overvågning af motorvejstrafikken samt i tilfælde af uheld, alarmering og indsats.

TRAFIKSIKKERHEDEN

9. Togdriften over Storebæltsforbindelsen består dels af langsomt kørende godstog, som har behov for ca. 9 minutter til at passere Vestbroen, dels af hurtigt kørende passagertog, som har behov for ca. 5 minutter til passagen. Vejtrafikken over broen vil løbende blive afviklet, hvilket vil medføre trafik på broen hele tiden. Generelt forventes det at tage under 8 minutter for biltrafikken at passere Vestbroen.

PROCEDURE FOR ALARMERING VED FARE FOR PÅSEJLING AF VESTBROEN OVER STOREBÆLT

10. Når VTS Storebælt vurderer, at der i et skibs besejlingsforløb mod Vestbroen er ved at opstå en situation, der kan udgøre en fare for Vestbroen, underrettes politiet, Banestyrelsens fjernstyringscentral i Roskilde og A/S Storebælts trafikvagt straks om situationen.

11. Det skal bemærkes, at ovenstående er gældende i de situationer hvor skibet :

- er på 1.000 DWT og derover,
- er på 300 – 999 DWT med kurs mod den lave del af Vestbroen,
- har en mastehøjde på over 18 m,
- er mindre end 1.000 DWT med farlig gods jfr. IMDG-code for søtransport.

Detaljeret beskrivelse af VTS Storebælts alarmeringsprocedure se Operationelle alarmprocedurer for VTS Storebælt [08].

a. Alarmering.
I de situationer hvor VTS Storebælt vurderer, at et skib vil påsejle broen indenfor 10 minutter eller i tilfælde hvor en pludselig fare for påsejling af broen opstår, aktiveres alarmeringen der medfører, at der tages øjeblikkelige skridt til at regulere/stoppe såvel motorvejs- som togtrafikken.

b. Varsel om påsejlingsfare 30 - 10 minutter.
I de situationer hvor VTS Storebælt vurderer, at et skib muligvis vil påsejle broen indenfor 30 minutter til 10 minutter aktiveres varsling af politiet, Banestyrelsens fjernstyringscentral i Roskilde og A/S Storebælt. De tre myndigheder holdes derefter løbende underrettet om det videre hændelses-forløb, idet parterne iværksætter nødvendige foranstaltninger til afbrydelse af trafikken over broen.

12. Alle af VTS Storebælt afgivne alarmer skal umiddelbart efter afgivelse, følges op med en melding til Slagelse Politi, Banestyrelsens fjernstyringscentral i Roskilde og A/S Storebælts trafikvagt. I meldingerne skal VTS Storebælt så vidt muligt oplyse, hvor en påsejling af broen vil finde sted, samt om skibet er for nord- eller sydgående.

KOMMUNIKATION

13. Til opretholdelse af en sikker kommunikation mellem de tre trafikdrifts-organisationer, er der i forbindelse med ovenstående varsling og alarmering etableret følgende kommunikationssystemer:

a. Primært kommunikationssystem (Alarmpanel).
Ved den ansvarlige for togtrafikken Banestyrelsen (Fjernstyringscentralen i Roskilde), VTS Storebælt og hos politiet er der installeret et alarmpanel der er et envejskommunikationssystem mellem VTS Storebælt og alarmmodtagere, således "sat op", at direkte og sikker kommunikation kan finde sted for udveksling af den tidligere omtalte livsvigtige kommunikation for regulering af vej- og togtrafikken over broen. Kommunikationen sker via SRO anlægget.

b. Dedikerede telefonlinier.
Tre dedikerede telefonlinier, således virkende, at når VTS Storebælt "løfter røret", ringer det hos Slagelse Politi Alarmcentral, den ansvarlige for togtrafikken Banestyrelsen (Fjernstyringscentralen i Roskilde) eller A/S Storebælts trafikvagt. Telefonlinierne skal være sikret mod "udkobling" på grund af stor travlhed på telefonsystemet, brud o.s.v. Telefonen skal virke som supplement for ovennævnte primære kommunikationssystem, samt til eventuelt at udbygge/oplyse mere om de signaler, der vil være sendt via det primære kommunikationssystem.

c. Backup telefonlinier
Telefonnumre nævnt sidst i denne procedure benyttes som backup til ovennævnte kommunikationsforbindelser.

AFMELDING

14. I de tilfælde, hvor det viser sig, at en tidligere afgivet melding om en mulig påsejling af broen viser sig ubegrundet eller en ulykkessituation er afhjulpet, skal denne straks afmeldes ved en annulleringsordre via alarmpanelet samt den dedikerede telefonlinie.

AFPRØVNING

15. Såvel de dedikerede telefonlinier som det primære kommunikationssystem skal afprøves mindst een gang ugentligt. Nærmere afprøvningsprocedure skal fremgå af driftsorganisationernes interne bestemmelseskompleks. For VTS Storebælt se Procedure 12 justering, kontrol og rapportering af fejl på VTS udstyr.

REKORDERING

16. Alle udsendelser på det primære kommunikationsanlæg (VHF) samt førte telefonsamtaler på de dedikerede telefonlinier rekorderes og gemmes i 30 dage hos VTS Storebælt.

Radar- og kamerabillede fra alle 3 konsoller og radarbilledet fra de 3 radarsits rekorderes og gemmes ligeledes.

ANSVARSFORDELING FOR REKVIRERING AF ASSISTANCE

17. For at sikre en hurtig og effektiv rekvirering af assistance til en ulykke, er der aftalt følgende forud fastlagte reaktionsmønstre:

a. VTS Storebælt rekvirerer nødvendig assistance fra skibe. Redningshelikoptere og dykkere rekvireres via Søværnets operative Kommando (SOK). VTS Storebælt vil via SOK foranledige eftersøgning og bjærgning af personer i vandet og løbende holde SOK og den lokale skibstrafik orienteret om situationen.

b. A/S Storebælt/Politiet foranlediger nødvendig assistance fra FALCK og/eller andre redningskorps.

c. Banestyrelsen (Fjernstyringscentralen i Roskilde). Ved toguheld sker tilkaldelse af assistance ved fjernstyringscentralens foranstaltning.

d. Politiet. Politiet iværksætter alarmering af indsatsenhederne og koordinerer den samlede indsats jf. de almindelige regler herfor (jf. Retsplejeloven §108).

PRESSEDÆKNING

18. Henvendelser fra pressen besvares af de enkelte centre, jævnfør centrenes egne procedurer herfor, idet omfanget af besvarelsen tilstræbes holdt indenfor rammerne af det enkelte centers arbejds- og ansvarsområde.

OPDATERING

19. Opdatering af denne procedure påhviler Chefen for VTS Center Storebælt.

Bilag: 1. Bro oplysninger for Vestbroen.

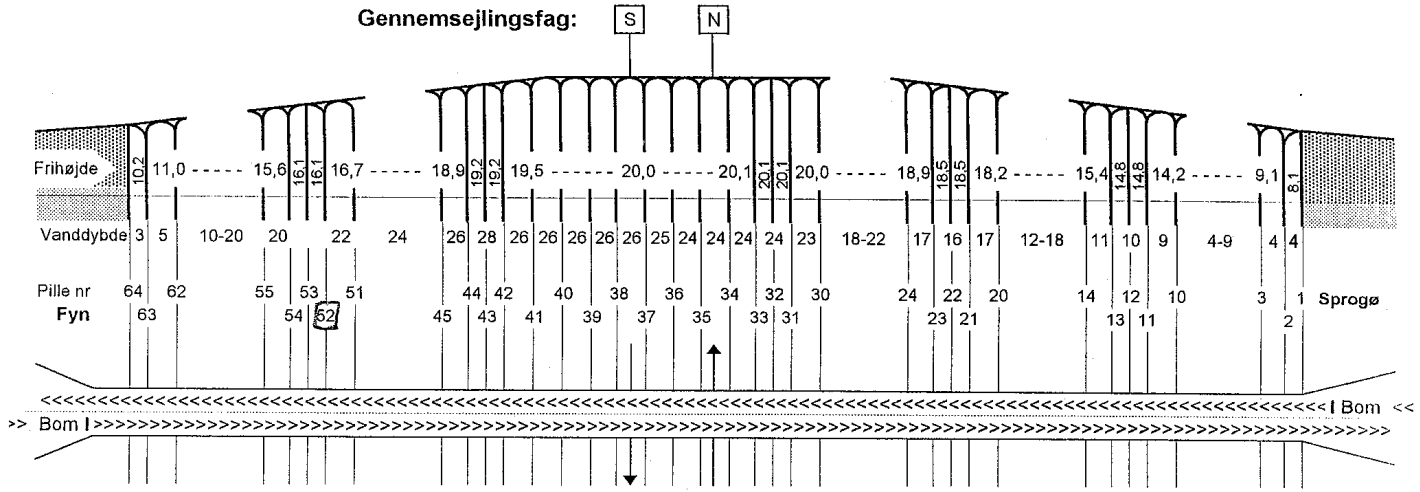
Telefonliste:	
Vagthavende officer Flådestation Korsør	5830 8207
Radarværkstedet, Flådestation Korsør	5830 8351 / 5830 8353
Vagthavende Radar-tekniker	4010 6536
OEDB værkstedet, Flådestation Korsør	5830 8355 / 5830 8356
Vagthavende OEDB-tekniker	4010 9783
Radioværkstedet, Flådestation Korsør	5830 8338
VTS 3	30243547
VTS 4	65301523 / 30247963
Chefen for VTS Storebælt	4015 2918 / eller privat telefon
Banestyrelsen Fjernstyringscentralen	4635 6997 eller dedikeret telefon
Vagthavende hos Politiet i Slagelse	5850 1448 eller dedikeret telefon
SRO-C	5835 1938
A/S Storebælts trafikvagt	5830 3050 / 5830 3051 eller dedikeret telefon
Vagthavende officer ved SOK	8943 3203 / 89433099 / 30256236

Bilag 1 til alarmeringsprocedure for Vestbroen

VESTBROEN - Arrangement - ikke målfast

Frihøjder er anført i m ved normalt højvande og viser den maksimale frihøjde midt i hvert fag under den nordlige brodrager (Jernbanebroen). Frihøjden ved bropillerne er 3,6 m mindre
Frihøjde under den sydlige brodrager (Vejbroen) er 1,3 m større end frihøjden under den nordlige brodrager (jernbanebroen).

Vanddybder i brolinien er ca-tal i hele m (nedrundet) ved normal vandstand, kun til orientering.
Der henvises i øvrigt til søkort.



Placering af bomanlæg til afspærring af vejtrafikken

VTS Storebælt Vestbroens arrangement med frihøjder mm.	Dato: 24-08-98 Rev.: 24-08-98 Godkendt: CH VTS J. BRANDT	VIIS Rådgivende Ingeniører Tel 3526 2555