Investigation report

C 2/2002 M

MS CITY OF SUNDERLAND, grounding off Hanko, January 1, 2002

SUMMARY

The Isle of Man-flagged car ferry ms CITY OF SUNDERLAND, belonging to the Manx Car Carriers shipping company, grounded off Hanko in the evening of January 1, 2002. The vessel was on her way from Copenhagen with a crew of eleven. A storm was growing in the area with the wind gusting to a speed of 23 m/s from a heading of 108° at the time of the grounding.

The vessel picked up a pilot at Gustafsvärn near the port at 1736 hrs. The tug AJAX arrived to assist in the berthing, but the berthing failed in the strong wind. The vessel had to leave port because her propeller was at risk. Because of the strong wind, the vessel could not leave by the same channel but had to turn into the south-west channel, which the master was not familiar with. The tug AJAX was attached to the bow when the vessel left port. The tug could not be released because the towing-hook release mechanism had frozen. The situation became dangerous.

A snowstorm blew up. The waves caused sea clutter on the radar, and the markers and weak targets were no longer visible. The first grounding occurred about five minutes after the release of the tug. The CITY OF SUNDERLAND grounded several times before finally coming to rest on the Västra Tistro shore at 2029 hrs.

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1 ACCIDENT AND ITS INVESTIGATION

1.1 Vessel

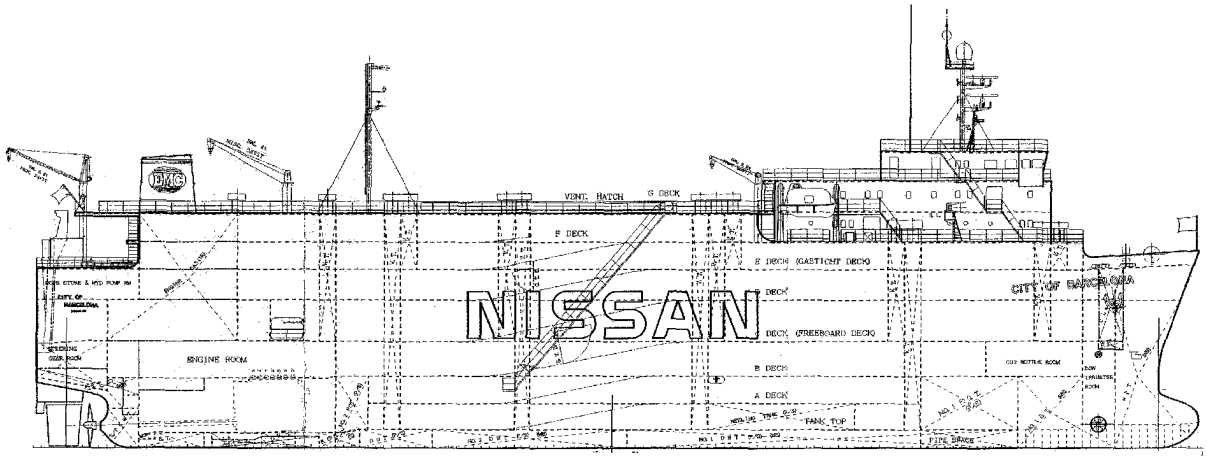


Figure 1. MS CITY OF SUNDERLAND and the general arrangement of her sister ship MS CITY OF BARCELONA.

1.1.1 General vessel data

Name	CITY OF SUNDERLAND
Home port	Douglas, Isle of Man
Shipping company	Manx Car Carriers
Type	Car ferry
Identification	MQPU6
IMO code	9046356
Nationality	United Kingdom
Year of construction	1992
Place of construction	Shin Kurushima Dockyard, Japan
Length, total	99.92 m
Width	20.6 m
Draught, max.	5.019 m
Dead weight	2402
Gross	9576
Net	2872
Main engine	B & W 7L35MC x 1
Engine power	4120 kW
Speed when loaded	16.1 knots
Speed at ballast	17.2 knots
Classification	Lloyd's Register +100 A1, +LMC UMS
Ice category	1A
Rudder type	Schilling High Lift rudder, power rudder
Propeller	Fixed wings, clockwise pitch
Bow propeller	585 ps (= 430 kW), (7 metric tonnes, pilot card)

Vessel registration documents

The following documents were appended to the Maritime Declaration:

Structure safety certificate	Lloyd's Register, valid until March 1, 2003
Classification certificate	Lloyd's Register, valid until March 1, 2003
Crew certificate for 11 persons	Issued February 1,1997, Douglas, Isle of Man
Cargo mark certificate	Lloyd's Register, issued April 30, 1998, London.
Last seaworthiness inspection	Lloyd's Register, February 14, 2001, South Shields.

1.1.2 Crew and traffic restrictions

The CITY OF SUNDERLAND was carrying the master, chief engineer, engineer, two mates, and six sailors. The total number of crew was eleven. This was the master's third voyage on THE CITY OF SUNDERLAND as master. He had been her master for two years.

The first mate had visited Hanko three times before. This was his first visit in winter[1].

The crew's working schedule had not been mentioned in the maritime incident form. The vessel had sailed from Copenhagen, so the work schedule consisted of normal sea watches, which were not too long.

The vessel's pilot had piloted the CITY OF SUNDERLAND before, and he had also piloted her sister ship the CITY OF BARCELONA. He had piloted both ships a total of ten times, in winter and in summer.

The CITY OF SUNDERLAND had no sailing restrictions.

1.1.3 Cockpit and its equipment

The CITY OF SUNDERLAND's cockpit was rather outdated. There was no dedicated navigation and steering point for pilotage. The radars had been installed far from the engine controls and the VHF telephone.

The bridge arrangement was designed to provide a free space for walking around all the consoles and to provide free passage when crossing from one wing of the bridge to the other.

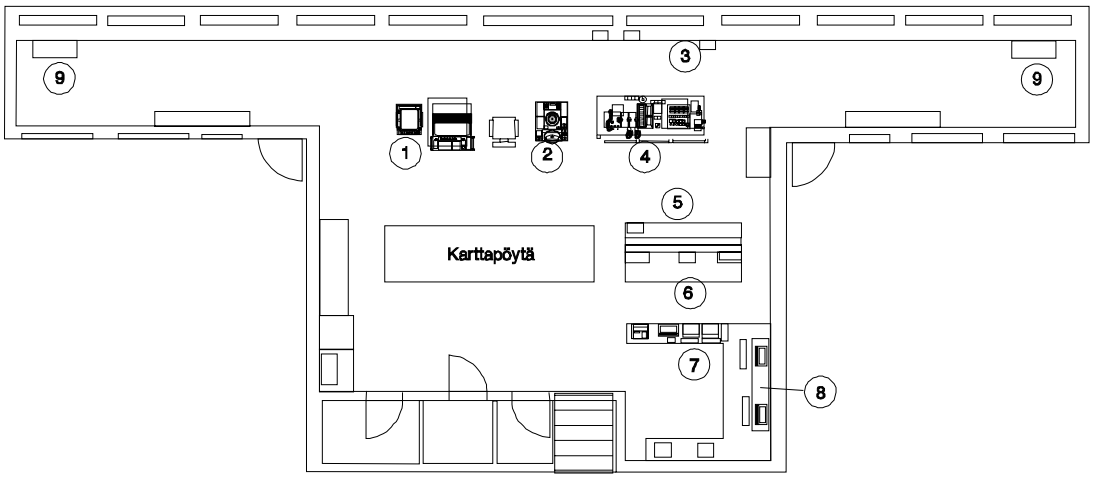


Figure 2. Cockpit arrangement of the CITY OF SUNDERLAND.

Table 1. Key for cockpit arrangement in figure 2.

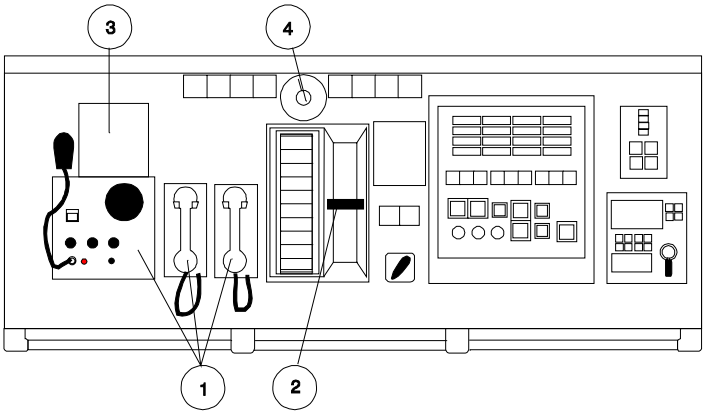
no	Indicating	no	Indicating
1	Two FURUNO radars	**5**	Console with a.o. course plotter
2	TOKIMEC steering post	**6**	Desk with a.o. radio telephone and barometre.
3	FURUNO DSC VHF radio telephone	**7**	Two computers, printer, telefax.
4	Controls and commands for main engine	**8**	GMDSS radio station
9	The vessel had one portable set of controls for engine commands, rudder angle and bow propeller that could be moved from one wing to the other. See Figure 5.		

[1] Hearing in connection with the Maritime Declaration.

The radio telephone used for navigation was on the front wall below the window. It was marked with a sticker reading “No. 1 VHF” (no 3 on figure 2). Consoles 5 and 6 were separated by a wall which reached to the ceiling. There was a curtain in front of console 7 that could be opened towards console 6.

There was a set of easily-read meters on the front wall of the cockpit near the ceiling, in front of the steering post:

- A wind gauge showing wind direction relative to the bow. The wind speed was displayed in m/s.
- Speedometer calibrated in knots.
- A gauge relating to the main engine.
- Rudder angle to port and starboard 70°.
- Tachometer for main engine.
- Clock.



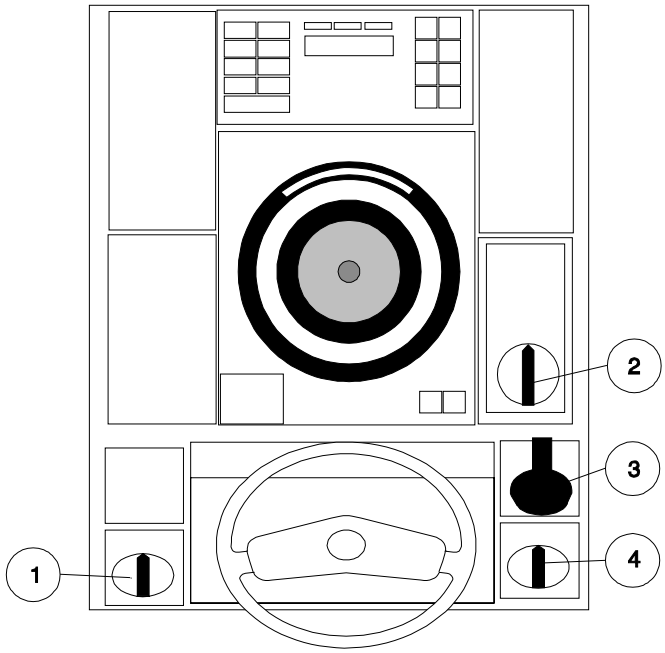
1. Intercom of vessel
2. **Engine command relay**
3. Speed and rpm table
4. Pressure air start for main engine

Figure 3. Engine control console on the starboard side of the bridge.

Table 2. Propeller rpm and vessel speed table on the engine console.

HARBOUR SPEED TABLE

Direction / Telegraph	AHEAD		ASTERN
	RPM	PROPELLER SPEED	RPM
DEAD SLOW	65	5.82 KNOT	65
SLOW	85	7.61 KNOT	85
HALF	115	10.30 KNOT	115
FULL	130	11.65 KNOT	130
EMERGENCY FULL	-	-	155



Key to figure 4:

1. Schilling rudder angle delimiter 50° and 70°.
2. Switch for the following steering modes:
   - AUTO or autopilot,
   - HAND or FU, follow-up steering (wheel)
   - NFU steering
3. NFU steering stick
4. A choice between two electric steering systems.

Figure 4. TOKIMEC company's steering post in the middle of the cockpit.

Figure 5. Controls on the starboard wing of the bridge.

Figure 6. The vessel's FURUNO radar monitors.

The vessel had two radars. The transmitters were of the same type but the monitor types were different. The magnetron frequencies were 9419 MHz ± 30 MHz, giving a wavelength of 3 cm (X-band). The transmitting power was 25 kW.

The radar on the left is a FURUNO FR-2020X-4A. The monitor was first manufactured in the late 1980s but discontinued about 1994-95. The monitor on the CITY OF SUNDERLAND had been approved for use on 22 March 1988. The screen diameter is 20 inches. The resolution is less than 20 metres at a range of 0.25'. The bearing resolution is better than 1°. The antenna diameter is 240 cms. The monitor operates in true motion if the log is connected to it. The monitor modes include Head-Up, North-Up and Course-Up, provided that the compass is connected to the monitor.

The radar on the right is a FURUNO FR-2022X-4A. The monitor was type accepted in 1989 and production was discontinued in 1995. The monitor on the CITY OF SUNDERLAND had been approved for use on 26 December 1989. The screen diameter is 28 inches. The resolution is less than 20 metres at a range of 0.25'. The resolution of the electronic bearing line (EBL) is ±1°. The antenna diameter is 8 feet (244 cms). The monitor operates in true motion if the log is connected to it. The monitor modes include Head-Up, North-Up and Course-Up, provided that the compass is connected to the monitor.

According to the maritime incident report, both radars were in use at the time of the accident. The positioning and steering equipment according to the maritime incident report and the Maritime Declaration was as follows:

Gyrocompass, three daughters	TOKIMEC TG 5000
Course plotter	TOKIMEC CRI
Autopilot (not in use on Jan 1, 2002)	TOKIMEC PR-800
Magnetic compass	NUNOTANI
Depth sounder	FURUNO FE G80
Decca-navigator (no beacons in the Baltic)	NAVSTAR 2000
GPS	FURUNO GP 500
Loran C (not in use on Jan 1, 2002)	FURUNO LC-90 MARK II

The vessel was equipped with radio equipment conforming to the Global Maritime Distress and Safety System (GMDSS) requirements. A DSC (digital selective calling) VHF radio telephone, DSC MF station and NAVTEX (navigational telex) can be identified from the figure 6.

A British Admiralty chart, number 3437, was in use at the time of the accident. The English catalogue of lights (last correction 31 December 2001) and the navigation guide were to hand.

The scattered positioning of the bridge equipment prevented efficient positioning and steering of the vessel. The bridge arrangement was not conducive to good pilotage. The equipment was up to the required specification.

1.2 Accident events and the actions leading to the accident

All times in this section are Finnish time (UTC +2).

1.2.1 Weather conditions

The CITY OF SUNDERLAND received the following NAVTEX weather report on New Year's Day:

> 01 0700 UTC JAN NORTHERN BALTIC: NOON SE OR E INCREASING TO 10-15 TONIGHT NE 14-18.

According to the forecast, the wind would shift from the south-east to north-east and pick up, but there was no warning about a snowstorm in the forecast.

Table 3. Development of the weather on January 1, 2002.

Document	Finnish time	Wind directn	Wind speed	Note
NAVTEX forecast	09.00	NE	14 - 18 m/s	wind picking up
Ship's log	13.00	SW	6 bf, n. 13 m/s	
II mate, witness statement	13.10	SSW	6 bf, n. 13 m/s	
II mate, witness statement	14.24	SSW	6 bf gusts 8 bf gusts 19 m/s	visibility 1,7'
Hanko Pilot, notification on VHF radio	15.15	160°	14 - 17 m/s	light icing in harbour
Ship's log	17.00	SSE	6 - 7 bf n. 13 - 16 m/s	
II mate, witness statement	18.00			visibility less than 1,0'. Info from pilot station
Master, Statement of Facts	19.20	ESE	30 - 40 kn 16 - 21 m/s	
Pilot, Incident report	about 19.30	SE	20 - 23 m/s	Pilot observation of wind in the harbour basin
Tug AJAX	about 19.30	ESE	17 - 21 m/s	observation of the master of the AJAX of wind in the harbour basin
Jussarö	18.00	125°	16,2 m/s average wind	19.8 max. in gusts
Utö	18.00	140°	17,8 m/s average wind	28.4 max. in gusts
Hanko Tulliniemi	18.35	115°	19,4 m/s average wind	21.6 max. in gusts
Hanko Tulliniemi	19.35	108°	19,3 m/s average wind	22.8 max. in gusts
Deck log	19.57			Abandon berthing
Deck log	20.29			Vessel touched bottom
Ship's log	21.00	SSE	40 kn , 21 m/s	
MRCC	21.38	108°	19,6 m/s average wind	23 max. in gusts , visibility 200 m

The wind speeds are logged from several sources fairly consistently. The CITY OF SUNDERLAND attempted to berth when the force of the wind reached its maximum.

1.2.2 Arrival at piloting point and preparation for piloting

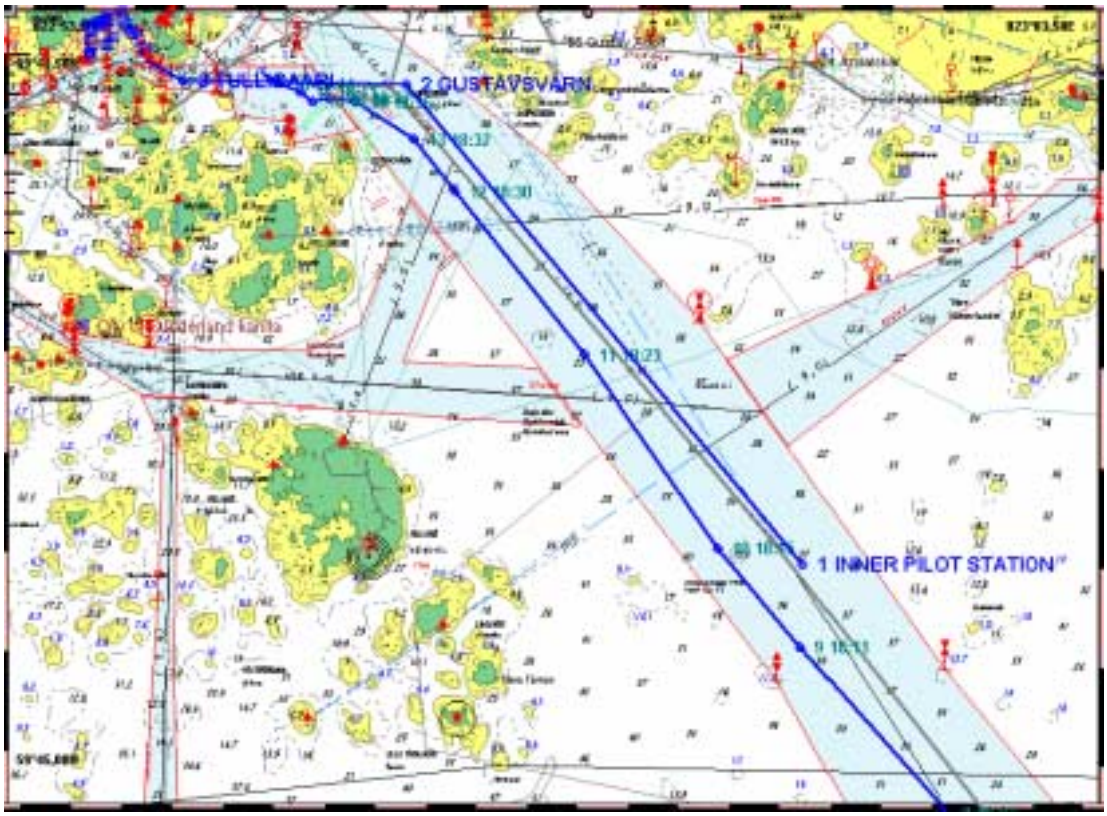


Figure 7. The CITY OF SUNDERLAND's passage plan from the pilotboarding point to the Tulliniemi strait and the vessel's passage according to the passage report of the Hanko VTS.

Table 4. The CITY OF SUNDERLAND's headings and speeds according to the MEVAK passage report.

	time			Speed	nm	Hdng	
1	17.37	59°39,3761N	023°02,8589E				
2	17.42	59°40,6361N	023°03,7588E	16,0	1,34	020,7°	
3	17.52	59°43,0163N	023°05,3086E	15,0	2,51	019,0°	
4	17.53	59°43,2163N	023°05,1986E	12,5	0,2	345,3°	
5	17.54	59°43,4163N	023°04,9885E	12,5	0,22	332,8°	
6	17.55	59°43,5663N	023°04,6985E	12,5	0,21	316,5°	
7	18.00	59°44,2763N	023°03,5284E	11,0	0,92	321,0°	
8	18.04	59°44,7663N	023°02,6583E	9,8	0,65	318,9°	
9	18.11	59°45,5862N	023°01,1781E	9,5	1,11	318,5°	
10	18.15	59°46,0762N	023°00,3580E	9,6	0,64	320,7°	
11	18.23	59°47,0362N	022°58,9978E	8,9	1,18	325,3°	
12	18.30	59°47,8462N	022°57,6877E	8,6	1,04	321,7°	Pilot boat approaching
13	18.32	59°48,1062N	022°57,2776E		0,33	322,4°	
14	18.36	59°48,2862N	022°56,6876E	6,0	0,34	302,1°	Pilot on board
15	18.37	59°48,3062N	022°56,4276E		0,13	279,6°	
16	18.39	59°48,2862N	022°56,2676E	4,2	0,08	257,5°	
17	18.41	59°48,3362N	022°56,1476E	4,8	0,07	310,5°	
18	18.44	59°48,3762N	022°55,9275E	2,2	0,11	290,8°	
19	18.46	59°48,4162N	022°55,7975E	0,6	0,07	302,3°	

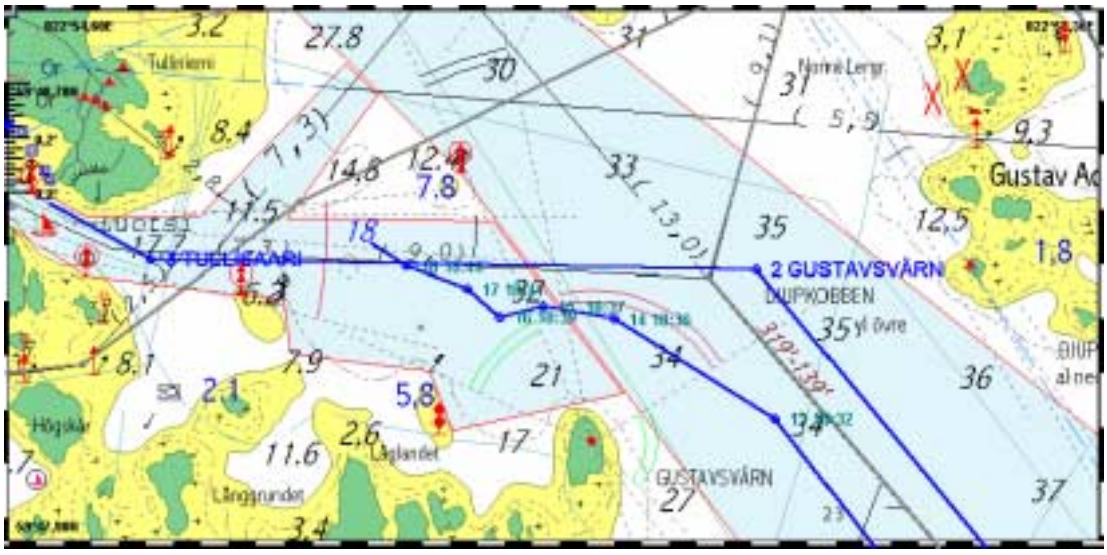


Figure 8. Pick-up of the pilot at 1836 hrs. After that, waiting for the tug.

Table 5. Extract from the vessel's passage plan. Bold text added by the investigation.

A	59 46,00 N	23 1,20 E	320°	3,1'	**INNER PILOT STATION** P.I. Gustavsvärn Lt/By 0,35' port	Come on to leading lights. Make a lee & embark Pilot close to Hanko 6 L/by. Out coming vessels have priority. Maintain P.I. (Parallel Index) off & rounding Gustavsvärn onto new course.
B	59 48,38 N	22 57,20 E	270°	1,1'	**GUSTAVSVÄRN** P.I. Hanko 5 L/By 0,17' to stbd P.I. N Cardinal L/By 0,08' to port	**If required tugs(s) usually wait just south of Hanko #5 L/By.**
C	59 48,38 N	22 55,00 E	298°	0,2'	**TULLISAARI** P.I. Tullisaari is 0,05' to port P.I. Cardinal 0,05' to stbd	Stay mid channel passing Hanko Port Control Station. When Cardinal buoy in line with stern, commence swing to port.
D	59 48,38 N	22 54,63 E			OFF RO-RO BERTHS #1 & #2	Manoeuvre to required berth.

The vessel had carefully prepared for the boarding of the pilot according to the specified checklist (table 6).

Table 6. Checklist ticked by the mate. The times have been converted to Finnish time.

Pre-Arrival Check List

Ship name CITY OF SUNDERLAND Port HANKO

	Description of test / Check required		Time
1	Half-hour notice to Engine room. Clocks synchronized.	Yes	17.18
2	Two steering motors on as per SOLAS Chapter V 19-1	Yes	17.30
3	Hand steering engaged and gear tested in all directions	Yes	17.30
4	Anchors cleared ready for use	Yes	17.30
5	All radars cleared ready for use	Yes	
6	Echo sounder on and position, data and time marked.	Yes	
7	Position, date and time marked on Course recorder.	Yes	
8	VHF on and monitoring required channels	Yes	
9	AMVER arrival message sent prior to entering pilotage waters	No	
10	Pilot contacted and ETA Pilot confirmed	Yes	16.15
11	Engine controls tested ahead and astern (When on manoeuvring RPM)	Yes	18.38
12	Passage Plan updated with any relevant arrival information	Yes	
13	Pilot Card completed and arrival draughts to hand	Yes	
14	Doppler log speed verified by observation	Yes	
15	Whistle tested	Yes	
16	Flags and light signals checked	Yes	
17	Engine room confirmed OP 097 completed and all systems ready for arrival	Yes	
18	Pilot boarding arrangements ready	Yes	
19	Power on mooring equipment and lines ready	Yes	
20	Deck lighting tested	Yes	
21	Fire main ready for use	Yes	
22	Berthing requirements agreed with port/terminal	Yes	

23	CFR 33 164.25 Requirements completed (U.S. Waters only)	No	

Completion of this Checklist recorded in Deck Log OP001 17.56 Hours LMT

There is no mention of using a tug in the above check form, but the passage plan table (table 5) contains the sentence “if tug(s) are required”. These directions leave the matter to the master’s discretion or to instructions issued by the harbour.

At 1615 hrs the mate, who was officer of the watch, reported to the Hanko pilot station that the CITY OF SUNDERLAND would arrive at the pilot boarding point at 1815 hrs (figure 7), with the pilot ladder on the starboard side. The mate notified the engine room that engine commands would start in 30 minutes.

At 1700 hrs the master entered the bridge to ensure that a pilot had been requested. He studied the latest NAVTEX weather forecast, according to which the wind would shift to the north-east in the evening and increase to 14-18 m/s. At that time, the wind was from the south-east at 13-16 m/s.

At 1745 hrs the master assumed responsibility for the steering from the mate. The steering was given to the helmsman.

At 1800 hrs the mate reported to the Hanko pilot station that the CITY OF SUNDERLAND had passed the Hanko 1 border marker. At that time the pilot station informed the vessel that because of the bad weather, the pilot would board only north of Gustavsvärn, on the starboard side.

Visibility had dropped to less than one mile. The first mate commenced his watch at 1800 hrs, but the master still continued to have responsibility for the steering. According to the first mate, the radar image was good. The buoys and the border markers were visible. The second mate’s final task before leaving the bridge was to mark the approach towards Hanko on the course plotter. He then left for his cabin.

The pilot boarded the vessel at 1836 hrs and was received by the first mate.

The master stated[2] that he had informed the pilot of the vessel’s heading and speed, of the propeller and bow propeller types, and of the draught of the vessel, etc. The first mate mentioned that the master had informed the pilot about the vessel’s steering data (“took the pilot through the pilot card”). According to the checklist, the pilot card was ready for the pilot when he boarded.

[2] Isle of Man, Witness declaration, Hanko, Jan 5, 2002.

Table 7. PILOT CARD at departure from Copenhagen at the end of December. Bold text entered by the investigation. The PILOT CARD has been copied from a photograph on which a flash created the blotted area.

PORT : Copenhagen DATE : 27/12/2001.			
DRAFT		FWD 4,2	AFT 5,2
MV CITY OF SUNDERLAND			
GROSS TONNAGE	9576 T	NET TNNGE	2872 T
L.O.A.	99,92M	BREATH	20,6 m
MAIN ENGINE	B&W 7L35MC X 1		
PROPELLER	1 X SINGLE RIGHT HANDED PROPELLER, VERY RIGHT HANDED WHEN GOING ASTERN		
RUDDER	1 X SCHILLING MONOVEC MAX ANGLE 65 DEGREES.		
BOW TRUST	1X 585 PS 7,0 M TONNES, EFFECTIVE RANGE FROM STOP TO 5 KNOTS. AT 25 KNOTS .. (blotted area) .. .. WIND TRUSTER NOT EFFECTIVE		
MANOEUVRING SPEEDS;			
FULL AHEAD	9,7 KNOTS	HALF AHEAD	8,6 KNOTS NB CRITICAL RPM
SLOW AHEAD	6,4 KNOTS	DED SLOW AHEAD	4,9 KNOTS
GENERAL NOTES:			
STEERIG; VESSEL WILL STEER OK WITH ENGINE GOING AHEAD; NEEDING MORE RUDDER AT DEAD SLOW AHEAD, BUT WILL LOSE STEERAGE AS SOON AS ENGINE STOPPED.			
RUDDER; FOR MAXIMUM LIFT OF STERN USE 40 DEGREES HELM. AFTER THIS 65 DEGREES THERE IS LESS LIFT BUT A REDUCTION IN HEADWAY THUS A THRUSTER EFFECT IS OBTAINED. KEEP RUDDER MIDSHIPS WHEN GOING ASTERN. WHEN MAKING STERNWAY USE RUDDER WITH AHEAD KICK ON ENGINE.			
THE VESSEL SUFFERS FROM HIGH WINDAGE AND THRUSTER WILL CEASE TO BE EFFECTIVE WITH 25 KNOTS WIND ON BEAM OR RELATIVE AMOUNT. WINCHES ARE FAST AND 3 ROPES EACH END ARE ON DRUMS.			

According to the Pilot Card, the wind limit for the bow propeller is 25 knots, which equals about 13 m/s in direct wind on beam. The vessel also carried a table on the effect of the wind force on the hull of the ship.

Table 8. CITY OF SUNDERLAND. Estimated wind forces.

WIND SPEED m/s	WIND FORCE ON HULL (tonne). RELATIVE WIND DIRECTION FROM BOW		
	0°	45°	90°
5,2	0,69	1,93	2,64
7,8	1,56	4,34	5,94
10,4	2,78	7,72	10,56
13,0	4,34	12,07	16,51
15,6	6,25	17,38	23,77
18,2	8,51	23,65	32,35
20,8	11,11	30,89	42,25

According to table 8, the vessel could stand a 13 m/s wind of 16.5 tonnes directly on her beam. The bow propeller power was 7 tonnes, so a lateral force of more than 9 tonnes could be achieved by coupling the effects of the main engine and the Schilling rudder.

The wind direction was 108°. The bearing to the pier was 170°, which meant that the relative wind direction would have been 62° from the bow at the pier. The wind direction did not help matters, since the wind would have been almost directly on the vessel's beam when approaching the pier. The wind speed according to the ship's log was 13-16 m/s, and this exceeded the CITY OF SUNDERLAND's wind limit. The assistance of a tug was required.

When the pilot boarded the ship, he asked the master if a tug had been ordered. The master said that one could be requested. The pilot asked the tug AJAX to assist. According to the Maritime Declaration, the tug took 20 minutes to arrive. While waiting for the tug, the master and the pilot discussed the berthing.

The tug AJAX arrived at 1855 hrs.

1.2.3 Berthing attempt

The harbour's plan was to berth the ship at pier 2, as pier 1 was supposed to be used for something else. This was not the case, however, so there was a choice of two piers. The master has reported that it was his understanding that the pilot knew the local conditions, so he left the choice of pier to him. The pilot decided to berth at pier 2, with the ship's port side towards the pier.

The pilot discussed the method of berthing with the tug's master. The pilot instructed the tug to position herself on the starboard side of the CITY OF SUNDERLAND, so as to be ready to push the vessel towards the pier when the wind started to push her away[3].

The master, the pilot, and the helmsman were on the bridge.

[3] Report of the master of the AJAX.

The master ordered the crew to the bow and to the stern, to be ready to moor the ship. The mate went to the bow and the first mate went to the stern. At 1920[4] hrs the vessel was turned in the outer port, south of pier 2, and she then approached the pier stern first (figure 9).

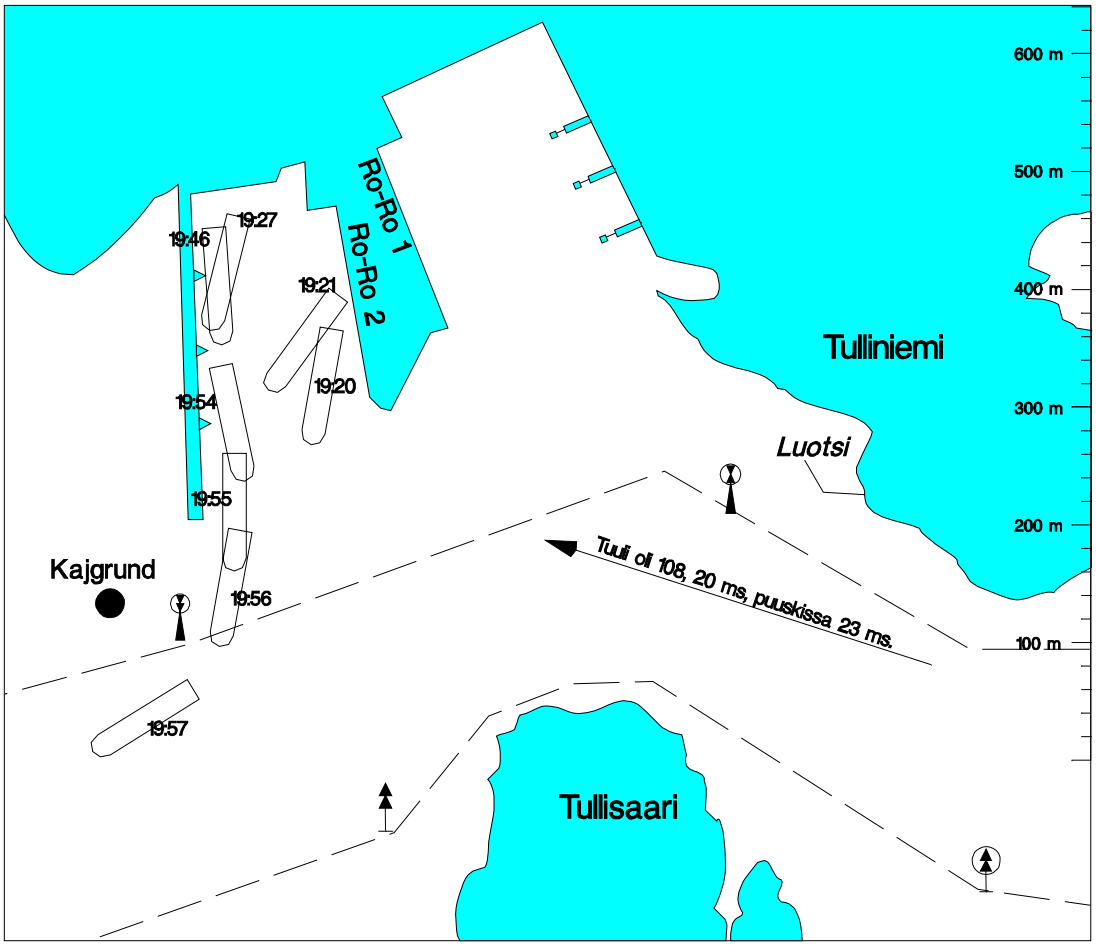


Figure 9. The CITY OF SUNDERLAND's position in the harbour basin is estimated, based on the Maritime Declaration, the witness statements and the course plotter.

According to the Tulliniemi station, the wind direction during the attempted berthing was 108°, the average wind speed was 19.3 m/s, and the wind was gusting to a maximum speed of 22.8 m/s.

[4] Master's Statements of Facts, Jan 8, 2002 and deck log.

Table 9. The CITY OF SUNDERLAND's compass headings according to the course plotter. Because of plotter error, 11 minutes was added to the time and 10 degrees to the heading.

UTC +2	Hdng	Observations by deck log and the investigation
19.20	190	Deck log: Swung around.
19.21	216	
19.27	194	Deck log: 'Vessel landed on starboard side dolphin'. (The vessel maintained this heading for about 15 minutes) The ice kept the vessel in direction.
19.42	-"-	Deck log ' Tug fast forward'. Vessel starts to turn port
19.43	180	Turning port
19.46	176	Turning starboard from here
19.51	185	Turning port from here
19.54	168	Turning starboard from here
19.55	180	Turning starboard
19.56	190	Turning violently starboard from here
19.57	238	Deck log: Abandon berthing. (Log 1-2 min late. Vessel already departed.)
19.58	244	Turn to starboard stops
19.59	246	Counter Rudder
20.00	236	Deck log: Out of Dock.
20.01	233	Starts to turn port
20.02	220	First VTS image of the report ½ minutes after this (Figure10).

There were no mooring posts on the sides of the CITY OF SUNDERLAND for the AJAX to tie onto. The vessel's side was icy, and this created problems for the AJAX when she tried to push against her side with her frozen bow rubber. The tug's bow rubber skidded and she could not produce a straight push. The solid ice in the harbour basin complicated the situation further. The tug could not hold her best possible pushing position, and her push was not sufficiently effective[5].

The master was on the vessel's port wing operating the engine command relay[6]. The CITY OF SUNDERLAND began to drift in the wind. The vessel lay halfway along the pier, diagonally to the pier, with her bow close to the fender piles on her starboard side, while her stern was still too far from the pier for the mooring rope to be thrown to the shore[7]. The vessel was drifting, but her drift was corrected enough to prevent the bow from hitting the fender piles. The pilot ordered the tug to withdraw to safety around the vessel's stern. The CITY OF SUNDERLAND was stopped by a fender pile at about 1927[8] hrs, where she remained for 15 minutes at a heading of 194°. The ice prevented the vessel from drifting further[9].

The pilot ordered the tug to the vessel's bow, and the master passed this information to the first mate. The master realised that one tug would not be enough to berth the vessel,

[5] Report of the master of the AJAX.
[6] Master, Statement of Facts Jan 8, 2002.
[7] Maritime Declaration p. 25.
[8] Master's Witness Declaration Jan 5, 2002.
[9] Telephone conversation with pilot on March 22, 2002.

and he asked the pilot about the possibility of getting another tug. The ship would remain resting on the fender pile[10] until it arrived. The pilot informed him that the other tug would have to be dispatched from Helsinki and that it would take 6-7 hours.

Between 1942 and 1954 hrs the vessel was turned from heading 194° to 168° (table 9). In the Maritime Declaration session, the pilot explained that the idea was to try to move the ship so that it rested on the next fender pile. According to the course plotter, the vessel's heading initially changed parallel to the breakwater. The stern was manoeuvred past the last fender pile and the ship managed to lean on the next fender pile. However, she did not stay there. The pilot had to make a quick decision as the ship was in danger of drifting in-between two of the fender piles.

The CITY OF SUNDERLAND was pivoting on one fender pile. The master asked the first mate about the situation at the stern. The first mate reported that the ship would have to reverse three metres in order to get the straight section of her side against the fender pile.

The tug AJAX was fastened by two short lines to the middle mooring point of the CITY OF SUNDERLAND's bow. The pilot concluded that the ship could not rest on one fender pile, since there was a risk of damaging the rudder and the propeller. The pilot considered that it would be impossible to hold the vessel steady in this position. The wind was increasing and it would take too long to wait for another tug to arrive. At 1954 hrs the CITY OF SUNDERLAND's stern swung towards the breakwater, just as the curved section of her bow came alarmingly close to one of the fender pile light posts.

The CITY OF SUNDERLAND was in a dangerous position, and the pilot ordered the AJAX to pull her to prevent her propeller from striking the breakwater. The pilot and the master jointly summed up the situation as follows: "To avoid further damage to the ship, we decided to leave the harbour and use the fairway via Albertsklackarna to return to the Hanko road[11]." The pilot ordered half ahead. The master was relieved to see that the tug was pulling[12]. Despite this, the master explained both in his witness statement and in the Maritime Declaration that he wondered (or was worried) about the pilot's new choice of fairway, and also about the fact that the pilot did not discuss the vessel's departure with him. The pilot stated the following in the Maritime Declaration session: "I said that in my opinion it was better to take this round-about route. I did not name the route, but only that we should go around by another route. I am well aware that they never use it when they normally arrive in Hanko".

The first mate asked the master about the situation when he saw that the vessel was moving ahead. The master replied: "It looks like we are heading to anchor somewhere." The first mate remained at the stern until the vessel had passed the tip of the breakwater.

[10] Maritime Declaration p. 25.
[11] Incident Report, Finnish Maritime Administration, Hanko 1.1.2002, signed by the pilot and the master of the CITY OF SUNDERLAND.
[12] Master's witness statement, Jan 5, 2002. p. 5.

According to the master, the intensity of the wind and the waves increased, the visibility deteriorated and the wind whipped up the snow from the pier. The pilot continued to give orders to the tug. Because the commands were not given in English, the master asked the pilot what his intentions were and where the vessel was heading so that he could inform the first mate. The pilot said he would steer the vessel back to the roadstead to wait for the other tug. The master passed on this information to the first mate and to the engine room.

1.2.4 Attempt to move to the waiting point

According to the pilot, the decision to leave the port area could no longer be delayed. The vessel needed more speed to prevent the wind from pushing her stern and propeller against the breakwater. The tug pulled her bow against the wind to port, while her stern was also pushed to port using the rudder. Despite this, the vessel's stern hit the light posts of two of the fender piles. Initially the intention had been to turn to port into the same fairway from which they had come[13]. This could not be done as there was again a risk of damaging the propeller. If the vessel could turn to starboard, however, there would be a chance of pushing the vessel's stern sufficiently against the wind to clear the breakwater. This manoeuver was successful and the CITY OF SUNDERLAND passed the breakwater without incident. One dangerous situation led to another and the ship ended up on a more difficult fairway. The tug had to use a short towline, and this was dangerous in a situation where the towing speed was greater than that required by the initial plan. The short line called for very precise steering by the tug's master, as well as prompt reactions to any changes affecting the steering. The steering was also complicated by the radio traffic between the tug's master and the pilot. The tug's master stated in the Maritime Declaration that he remembered the pilot complaining about the poor quality of the radar image.

The master explained that he had not previously used the fairway that the pilot had turned into, but that he had relied on the pilot's professional skills[14]. The pilot used this fairway every week[15].

The vessel was drifting considerably, and the pilot was giving commands to the tug's captain in order to keep the vessel on the fairway. The tug occasionally used her searchlight. The plan now was to move along the Albertsklackarna line and then to release the tug after the Gråskärsharun turn[16]. The pilot ordered the tug to be released as agreed with her master. The tug's hook-release mechanism had frozen, which prevented the release of the towline. Because the tug was pulling, the pilot was unable to determine how the wind was affecting the vessel's steering. In addition, he had to cope with the radio traffic between himself and the tug. The entire crew was at the bow attempting to release the tug. Only the pilot, the master and the helmsman were on the bridge.

[13] Master of the AJAX at the Maritime Declaration hearing.
[14] Master's Statement, Jan 1, 2002.
[15] Pilot in the Maritime Declaration session, Jan 8, 2002.
[16] Master of the AJAX at the Maritime Declaration hearing.

The pilot asked if the vessel had a searchlight. There were revolving searchlights behind the bridge wings, which were intended for illuminating piers during berthing[17]. The searchlight beams were wide and did not reach far. The first mate arrived on the bridge to relieve the helmsman for a short time so that he could shine the searchlight ahead as requested by the master. According to the pilot, the searchlights did not help. The tug's master had no recollection of the CITY OF SUNDERLAND using her searchlights.

It was discovered in the Maritime Declaration that somebody had switched on the blinking message-light inside the bridge. In the pilot's opinion this had happened at rather a late stage, and he was unable to tell whether it had had any effect on their ability to see. Apparently, the intention had been to use the blinking light as a substitute for the searchlights.

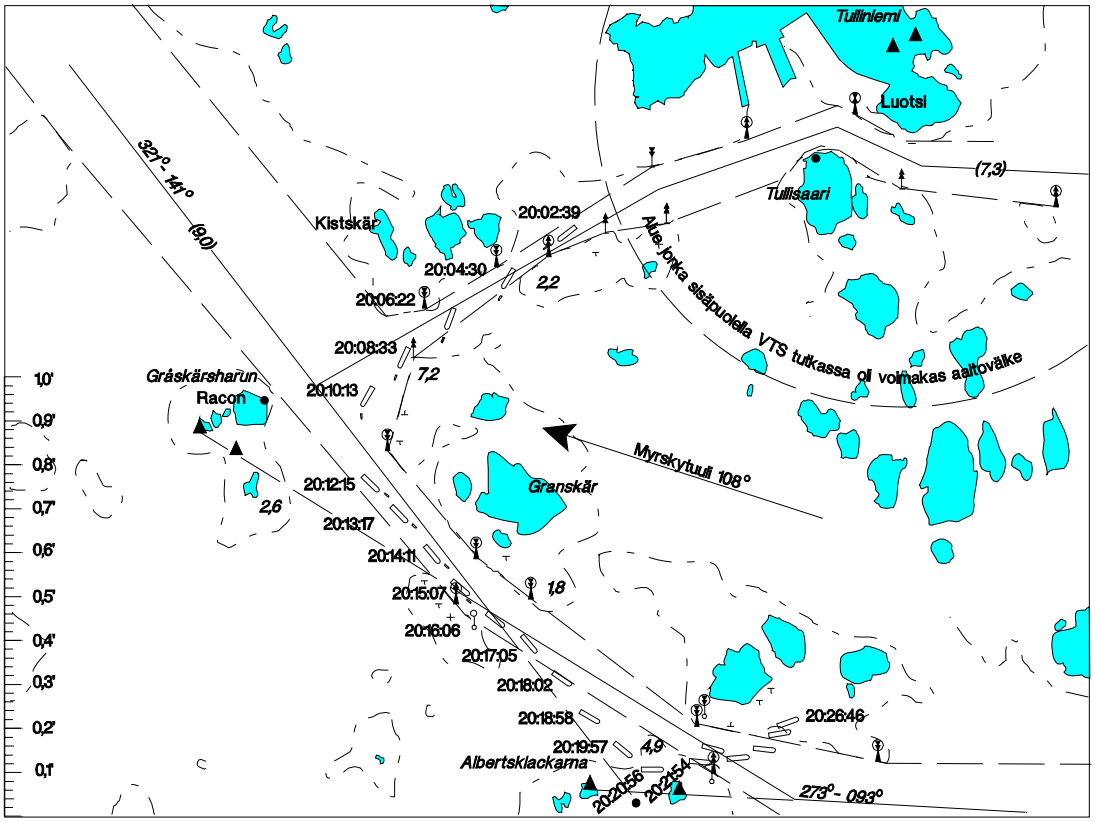


Figure 10. The CITY OF SUNDERLAND's passage according to VTS tracking.

There is an adjustment error in the VTS image. The image of the VTS radar video has to be moved about 90 metres to heading 150° on the chart. The vessel's position is shown in figure 10 to an accuracy of about two shipwidths.

[17] Master's statement in the Maritime Declaration session.

Table 10. VTS images in figure 10 and the corresponding course plotter headings.

UTC+2 VTS image	Hdng	Observations of the investigation
20.02.39	220°	
20.04.30	210°	Drift about 24°.
20.06.22	200°	Drift about 30°.
20.08.33	205°	
20.10.13	210°	Vessel starts to turn to port. Speed 4,6 knots during the last 8 minutes
20.12.15	135°	
20.13.17	136°	
20.14.11	140°	
20.15.07	130°	Speed 6,7 knots during the last 3 minutes
20.16.06	129°	
20.17.05	140°	Turns momentarily to heading 140 but turns immediately to port
20.18.02	125°	
20.18.58	120°	
20.19.57	130°	
20.20.56	090°	
20.21.54	095°	
20.22.55	105°	
20.23.56	110°	
20.24.51	085°	
20.25.50	080°	
20.26.46	070°	(last VTS image used by the investigation)
		Vessel grounded immediately after this. Mate observed heading 066° on entering the bridge after the grounding
	060°	
	056°	
	070°	Vessel starts to turn on the rock
	322°	Turning stopped.

When the first mate entered the bridge, the master warned him about the slippery floor. The window on the bridge port wing had been left open after the failed berthing attempt, and it had snowed inside. The pilot stayed on the starboard side of the bridge to avoid the slippery floor. The first mate ordered the helmsman to mop the floor before somebody broke a leg on it, then he requested permission to go and change into dry clothes. He had just got over pneumonia, and the doctor had told him to be careful not to catch another cold in case there was a recurrence of the illness. The master dismissed the first mate. The first mate ensured that the helmsman had the right heading and then he left the bridge. The master, the pilot and the helmsman remained on the bridge.

The master helped the pilot to change the radar range and adjust the sea clutter control. Because the first mate had left, the pilot again needed the master to help him adjust the radar image. According to the master[18] there was clutter on the radar, but he didn't have time to adjust it properly as he had to rush to the engine command relay to deal with the numerous engine commands.

[18] Master's Statement Jan 1, 2002.

The pilot stated during the Maritime Declaration hearing that he found it impossible to interpret the radar image. When the vessel had turned and was approaching the Albertslackarna islands, he tried changing to a longer range to try and bring in targets from farther away, but this did not help. He also tried using the Anti-Clutter control to clear the sea clutter, which was obliterating the sea markers and small targets, but this also did not help. In the pilot's opinion it should have been possible to get a usable radar image, as this had been attained on other ships under similar conditions. The pilot rated the usefulness of the radar as "limited or non-existent".

The tug arrived on the starboard side of the CITY OF SUNDERLAND's bow. The master saw a buoy about 50 metres to starboard of the bow. This buoy was apparently an east buoy that had been passed at 20:15:07 (figure 11). The tug's searchlight lit up the buoy and her master told the CITY OF SUNDERLAND to steer to port. The pilot ordered the helmsman to turn to port and commanded full ahead. According to the tug's master, the CITY OF SUNDERLAND was on course when the towlines were released. It took about two minutes to release the towline after the command had been given. The towline was released at the south buoys[19] between 2015 and 2017 hrs. The AJAX's master stated that the CITY OF SUNDERLAND had continued straight on, and he reported on VHF channel 8 that the vessel had been too far to starboard. The tug moved to the next border marker in order to illuminate it with her searchlight.

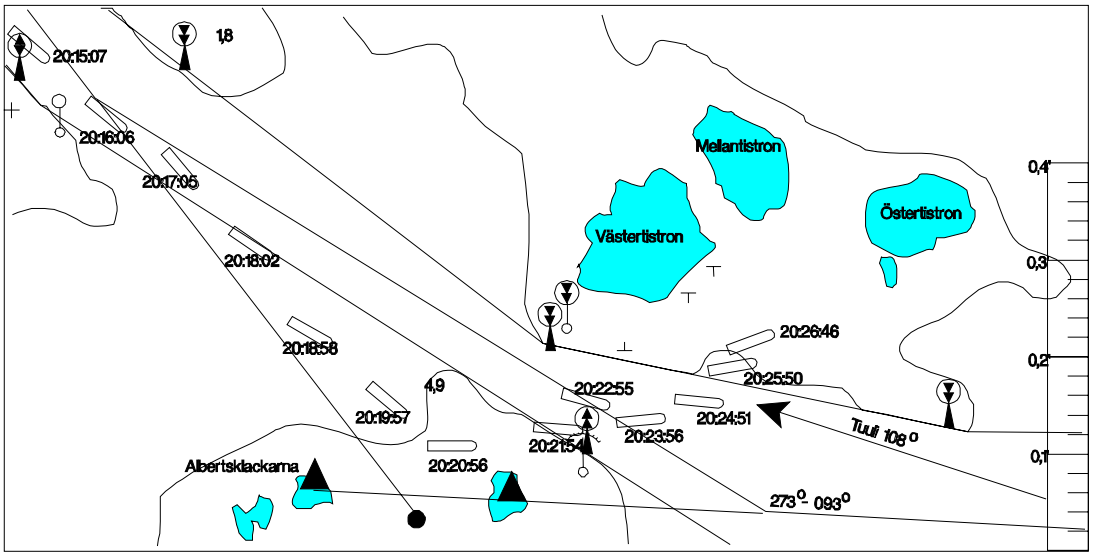


Figure 11. The CITY OF SUNDERLAND's passage before the grounding.

The pilot started to curse the poor quality of the radar image immediately after the release of the tug. However, he said at the Maritime Declaration hearing that it would have been difficult to improve the radar image. The engine commands varied from half to full ahead. The master adjusted the radar image and then rushed to change the engine command. The pilot changed the range, which again required a re-adjustment of the radar video.

[19] Master of the AJAX at the Maritime Declaration hearing.

The vessel started to drift to starboard between 2016 and 2018 hrs (figure 11).

1.2.5 Grounding

After the tug was released, the CITY OF SUNDERLAND started to drift off the fairway. The main cause of this was the sea clutter on the radar. The tug's radar antenna was low down, so the sea clutter did not affect her radar as badly as that of the CITY OF SUNDERLAND. The fairway was more visible from the tug, and she could pull the CITY OF SUNDERLAND in the right direction. Several factors played a part in causing the vessel to drift off the fairway: the unexpectedly large drift angle after the release of the tug, the poor radar image, and the non-existent visibility.

The delay in releasing the tug essentially complicated the piloting. The pilot had no time to determine the vessel's drift before approaching the straits ahead. About five minutes after the tug was released, the pilot was pacing the bridge. The master inquired about the quality of the radar image and at the same time the pilot said that the ship had hit something. According to the tug's master, the time from the release of the towline to the first grounding was less than 5 minutes[20].

The master felt another blow on the port side. He described the situation during the first grounding as follows: "I could not see anything - everything was white and because of frequent instructions to the engine room, I could not leave the telegraph, except when I had to dash to adjust the radar quickly for the pilot."

The first mate was changing his clothes and he had heard the order to release the tug on the radio telephone. He had been on his way to the bow to assist, when he felt the ship hit something and he rushed to the bridge. When he reached the bridge the ship grounded again; the engine was at full ahead. The first mate shouted "Stop engine"[21]. The master rang to stop the engine and the ship stopped. The master marked the time of the grounding on the depth sounder plotter. The pilot reported the incident to the Maritime Rescue Coordination Centre (MRCC).

The master went to the chart desk and marked the ship's GPS location: 59° 47,1'N 022° 54,29'E, on the shore of Västra Tistron island. The master ordered the first mate to check for damage and to check on the crew situation. The first mate called the mate onto the bridge and then he went to carry out the master's orders.

When the mate entered the bridge, the engine was stopped and the ship was on heading 066°. He heard the master order the boatswain to drop the anchor. According to the master, the anchor was dropped at 2037 hrs. The mate asked the master if a distress signal should be sent but the master said the pilot had already sent it. The mate then entered the cockpit and noticed that the floor was dangerously slippy.

[20] Master of the AJAX at the Maritime Declaration hearing.
[21] Witness statement of the first mate, Jan 5, 2002.

1.3 Rescue actions

The mate started to fill out the grounding checklist and to keep a record of actions taken.

The crew immediately started to check the vessel for damage. At 2110 hrs the engine room reported that there was a leak in the empty diesel-fuel tank #2. There were dents on the port side of the vessel, between arcs 47 and 50. At 2245 hrs a leak was detected in ballast tank #2, the pipe tunnel and the washing water sluice tank. The first mate inspected the cargo holds. A couple of the manholes were leaking. The nuts in these were tightened and the leaks were stopped. The MRCC and the ship's agent were informed of the damage[22]. The list was 4° according to the first mate and 3° according to the mate, and based on this the list remained stable. The bilge pump was switched on to remove water from above the double bottom.

The deck crane was turned and the railings removed in order to let a helicopter land. A frontier guard helicopter (OHVE) dropped their representative on board the vessel at 2337 hrs. He performed an alcohol test on the master, the pilot and the helmsman. All were negative. The helicopter left after a few minutes[23].

Four soundings were taken around the ship and the intention was to take more in daylight[24].

The patrol vessel MERIKARHU and the oil prevention vessel HALLI remained in the vicinity during the night. The wind speed was still 30 knots (15 m/s) and the wave height about 2 metres. The master requested another tug. She would arrive in 7 hours.

January 2nd:

The frontier guard sent a liaison officer to the ship at 0115 hrs. He stayed on board until it was certain that the crew was in no danger.

The director of the rescue company arrived at 0915 hrs.

The rescue crew arrived at 2320 hrs.

January 3rd:

The tug NEPTUN and the barge PATNER arrived on the scene. Ballast tank #2, the fresh water tank, the fore and aft peaks, and the left list tank were emptied. The cars from decks E and F were moved two decks down to decks C and D.

The tugs AJAX and NEPTUN pulled the CITY OF SUNDERLAND afloat at 1640 hrs. There were no oil leaks. At berth, the draught of the vessel was 4.52 m at the bow and 4.78 m at the stern.

[22] Master's statement Jan 1, 2002 ship's journal.
[23] Witness statement of the master, Jan 5, 2002.
[24] Witness statement of the mate, Jan 5, 2002.

1.4 Accident investigation

On 24 January 2002 the Accident Investigation Board decided to appoint a board to investigate the accident. Risto **Repo**, accident investigator, sea captain, of the Accident Investigation Board was appointed as chairman of the board. Kari **Larjo**, sea captain, and Kai **Valonen**, M.Sc (Tech), both experts of the Accident Investigation Board, gave their consent to serve as members of the investigation board.

The investigations on board the vessel and at the accident scene were conducted in co-operation with a representative of the investigative authority of the Isle of Man. The investigative report of the Isle of Man is a separate document.

2 ANALYSIS

2.1 Wind limits

2.1.1 Wind limits for vessel steering in port

The vessel's PILOT CARD indicated that the bow propeller could not manage if the wind coming directly on beam exceeded 13 m/s. If the wind comes at about 60° off the bow of the vessel, a strong lift is created on the leeward side of the hull, which causes more drift than the wind directly on beam. The direction of the wind when the CITY OF SUNDERLAND was berthed was the worst possible (figure 12). The vessel had a wind force table (table 8), where the wind on beam is correct but the force of a head wind coming at 45° is too small. The relative hazardous wind direction was not indicated.

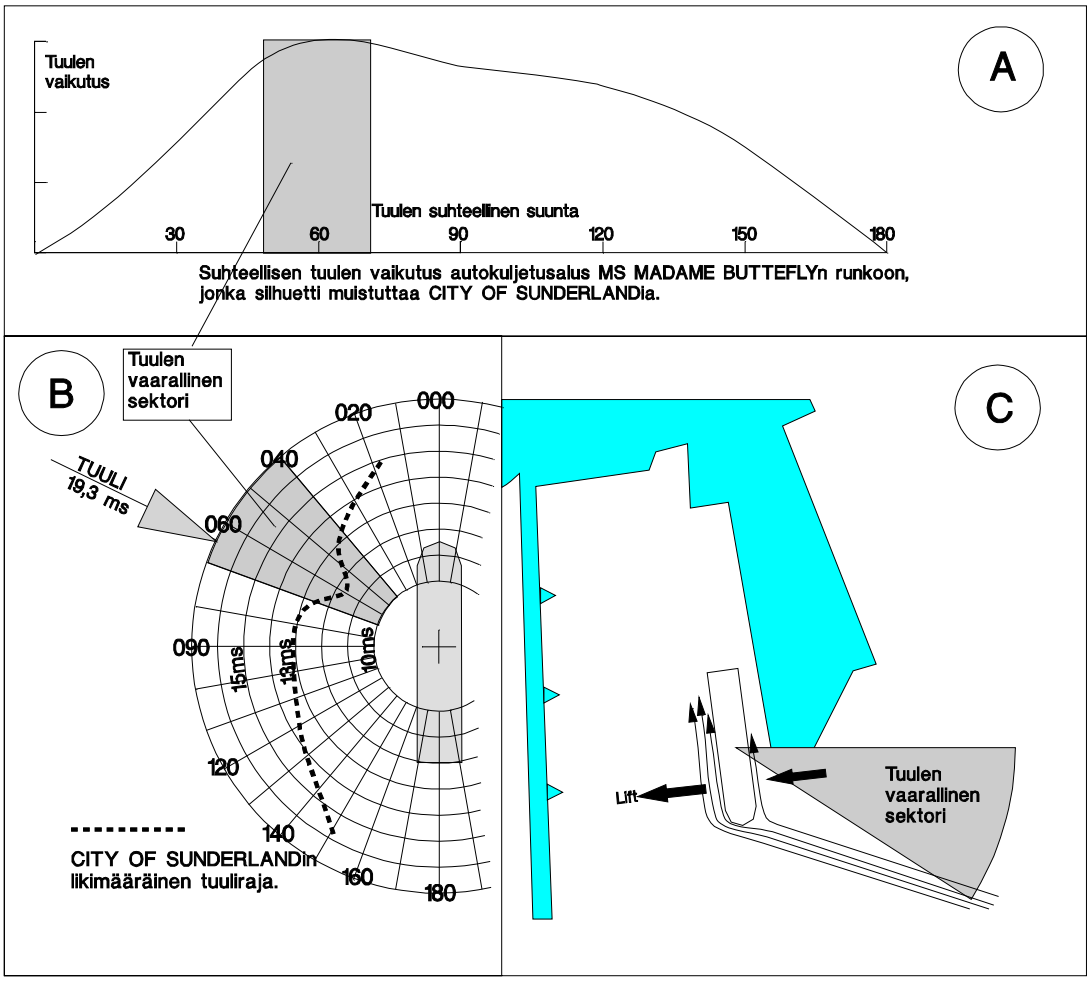


Figure 12. Estimated wind limit for the CITY OF SUNDERLAND based on the PILOT CARD and on the general wind limit definitions[25]. The wind limit was exceeded.

[25] Nils Norrbin 1983. fig. 6.14 and 6.15.

The wind limit for the vessel had clearly been exceeded, according to the information on the vessel. The wind direction was the worst possible, because it was blowing directly through the strait between Tulliniemi and Tullisaari. The master explained in the Maritime Declaration session that: “The pilot knows the conditions of the harbour best, and that he considers the opinions of the pilot when making a decision”. The pilot said that: “Ships had been brought in under similar conditions before”. By “similar conditions”, the pilot apparently meant that this referred to the use of a tug. He proposed that a tug be requested and the master agreed.

According to the first mate, the master and the pilot did not discuss the possibility of waiting for the weather to improve. There was no discussion of an actual wind limit. According to the pilot, events became impossible to predict once the ship had started towards the harbour.

2.1.2 Definition of wind limit for the vessel

The wind limit can be defined on a desktop computer, using a mathematical model. The underwater section of a mathematical model for conventional ships can, in many cases, be created with the help of line drawings alone. The definition of the wind moment always requires a wind tunnel experiment.

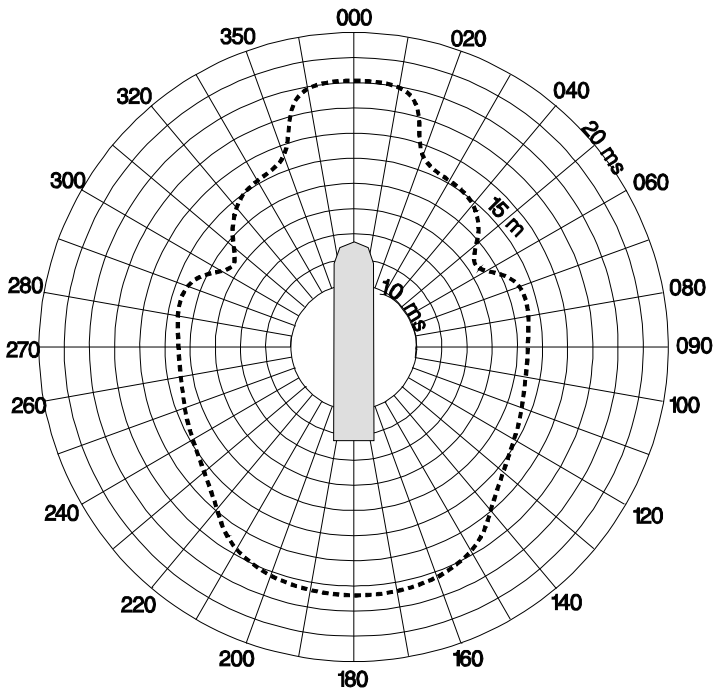


Figure 13. Imaginary example of wind limit without tugs.

Figure 13 represents the wind limit curve for an imaginary car ferry. The vessel has no speed within the harbour area. The wind speed is at 10 metres above sea level, since weather reports indicate wind speeds at this height.

The limit curve is defined so that the vessel is driven towards an imaginary berth. The wind limit is defined at an interval of 10 degrees by increasing the wind force by about 2m/s for each run until steering difficulties begin to appear. Then the precise limit value is defined.

Gusts also have to be taken into account. In the case of the CITY OF SUNDERLAND, the gusts were ±4 m/s. There is turbulence in the harbour area, which further increases the gusts by about ±2 m/s.

Water depth is fed into the program that uses a mathematical model. The program also needs the parameters for the piers and the shallow water mark. The easiest solution is to simulate this on an electronic chart. As a minimum requirement, the master should have the information in figure 13. The tugs can be added to the program by putting them in the middle of the run in predefined positions. If there are tugs assisting it is impractical to define the wind limit, since the wind limit cannot be defined for all tug types. The wind limit for tug use should always be defined separately.

The wind limit for the vessel for open-sea conditions is defined as if the harbour were in a fully open location.

Some shipping companies and ports have determined what effect the landscape and the buildings in the port area have on the direction and speed of the wind. This calls for a landscape model to be used in a wind tunnel to measure the changes to the air currents.

The result is a chart of the factors needed for different wind directions, and this is used to correct the wind at 10 metres, as indicated by the weather reports, in order to forecast the estimated wind for the port area.

2.2 Use of a tug

The wind surface area of the CITY OF SUNDERLAND is about 1300 m^2. It is measured by reducing the silhouette of the MADAME BUTTERFLY to the dimensions of the CITY OF SUNDERLAND. If the wind speed is 19.3 m/s, the tug needs to exert a force of about 30 tonnes to resist the wind. In gusts of 23 m/s, the force needed is about 50 tonnes[26]. The pushing power of the AJAX was 27 tonnes. The CITY OF SUNDERLAND's bow propeller had a push of 7 tonnes and the effect that could be produced with the Schilling rudder was probably the same, 7 tonnes. The total power would have been barely enough in a steady wind, let alone in the gusts. The wind limit was exceeded because only one tug was used. A second tug would have been needed.

The berthing failed because of the ice in the harbour basin and on the ship's side. The tug's bow skidded along the side of the ship. This was the first unpleasant surprise for the master and the pilot.

When the berthing failed, the tug was given the order to proceed to the bow. Short towlines were given by the CITY OF SUNDERLAND. This signified a port tow; the pilot intended to try to berth again. Because the vessel's propeller was at risk, the pilot had to change his plan quickly. The ship had to be moved away from its dependence on one fender pile. The master was relieved about this decision, but at the same time his

[26] Henk Hensen, Tug Use in Port, diagram on page 75.

chance of monitoring the safe passage of the ship was compromised, since the pilot had to choose a fairway that the master was not familiar with.

The second unpleasant surprise for the master and the pilot was the ship's departure from the port, and the forced turn to starboard towards Gråskäsharun because of the conditions. The piloting became significantly more difficult, which had not been the intention of the pilot. The hazardous situation forced him to choose a turn that would be safe for the ship at that moment.

According to the pilot, the intention was to use the tug to assist the vessel in the turn at Gråskärsharun and then to release her. This decision would hardly have been made if it had been known then that the release mechanism of the tug's tow hook had frozen shut. The tug would have been released earlier when the wind was from behind the cross-section of the rear of the vessel.

After the CITY OF SUNDERLAND had turned from port towards Gråskäsharun, she picked up speed steadily. The speed between Kajgrund and the start of the Gråskäsharun turn was about 4.7 knots. The average speed during the Gråskäsharun turn was about 5.5 knots and about 6.7 knots in a straight direction after the turn towards the buoy gate at Granskär. The master had a difficult task steering the AJAX, since the towline was too short for a speed of 4 knots. Had the AJAX's master made even the smallest error in the steering, the tug would have turned sideways and been capsized by the CITY OF SUNDERLAND. The master's steering of the AJAX was commendable.

The tow hook's release mechanism had frozen and it could not be operated from the AJAX's bridge. In the high waves, the AJAX's master had to steer her close to the starboard side of the CITY OF SUNDERLAND's bow in order to give some slack to the towline. The safety of the AJAX was compromised during this manoeuver. The AJAX's master did not mention his having had any problems with the steering, but he admitted that the short towline had given him trouble. He mentioned in the Maritime Declaration session that in the worst case the tug risked capsizing. He had no time to clarify the situation with the pilot.

Three AJAX crew members released the towlines with boat hooks. One of the towlines released easily, but according to the AJAX's master it took about two minutes to release the other one. The CITY OF SUNDERLAND was "fully on the line at the south buoys" when the towline was cast loose (figure 10). According to the VTS register, it took 3-4 minutes to travel from the end of the Gråskärsharun turn to the south buoys at Granskär. The pilot did not know precisely where the towline had been released.

The piloting was made more difficult when the towline froze. This was the third unpleasant surprise for the pilot, because he would have needed to concentrate on the radar navigation at this time.

2.3 Searchlight

During the towing, the tug AJAX's searchlight illuminated the markers. According to the pilot, the CITY OF SUNDERLAND's searchlights were of no help. The pilot stated twice in the Maritime Declaration that it was snowing heavily. In these conditions, the searchlight's beam would have reflected off the snow and onto the bridge. According to the pilot, the work lights on the deck caused distracting reflections on the bridge windows.

The use of the searchlights was discussed at the Maritime Declaration hearing. The pilot asked the master to switch on the searchlight immediately after leaving port. According to the master, the searchlights were situated on the wings and were intended for illuminating the pilot's gates, or piers. They had to be turned to point ahead. The master could not go onto the wing because he had to use the engine command relay, and the pilot could not use the engine command relay because it was too far from the radar.

The AJAX's master could not recall whether the searchlights had been on at any time during the towing. The pilot also did not see if the searchlights had been turned on.

According to the conversations, at some point the blinking message light (Aldis) on the bridge had been switched on. The first mate said he had not seen it switched on. The pilot said that the light had been switched on at a rather late stage, but that he was unable to estimate if this action had had any adverse effect.

In his witness statement the master explained that he had seen a light less than 50 metres off the vessel's port side. The only time a buoy was near the ship was at 20:03 (figure 10). It was visible without the searchlight. The master reported in the Maritime Declaration that when the tug came to the starboard side of the CITY OF SUNDERLAND's bow, the master had seen a buoy lying 2 compass points off the bow to starboard, and that the wind was pushing the vessel towards it. The master did not mention if there was a light on the buoy. This was the east buoy at Granskär (figure 10 at 20:15).

The buoy at Albertsklackarna was also discussed in the Maritime Declaration session. This was the north buoy that was lit on the starboard border of the fairway (figure 11). The pilot stated that the Helsinki VTS had reported that the buoy light was unreliable. The pilot could not confirm if the buoy light had gone off, but had he seen the light from the buoy, or seen the buoy with the searchlight, the knowledge of its position would have had more impact on his activities. Since the pilot confirmed that the grounding could have been avoided if he had seen the buoy with the searchlight, it can be concluded from his answers that the accident would have been prevented if the light on the buoy had been operating correctly.

In summary, it can be stated that the searchlights did not help. Because the blizzard made visibility difficult from the bridge, only the radar could have provided the necessary "visibility". The pilot believed that the searchlights would help, but that was not the case. This was the fourth unpleasant surprise for the pilot.

2.4 Radar use options

The first mate said that only one of the radars was on, but according to the maritime incident report both radars were on. Apparently only the best radar had been adjusted, but both were switched on. The radars had been adjusted for berthing, and not for moving to the winding fairway west of the port. This was the reason why only the best radar had been adjusted. The changing situation would have called for the other radar to be adjusted as well, but there was no time for this.

According to the pilot, the main radar[27] was adjusted during the turn at Gråskarsharun. The sea clutter was obviously not causing any problems while the vessel was moving towards Gråskarsharun. The wind came diagonally from the stern, and the wave height did not cause as much disturbance as it did after Gråskarsharun when the ship started to travel into a head wind.

As the sea clutter on the radar increased, the first mate was at the helm, the pilot was at the radar, and the master was running back and forth between the radars and the engine command relay on the left wing. The master was adjusting the engine power according to the pilot's instructions, and he also tried to adjust the main radar's image but did not have time to do this properly. The pilot tried extending the radar's range, but this did not improve the radar image. According to the pilot, the radar image could not be interpreted. The pilot also tried to reduce the sea clutter, but the weak targets disappeared under the clutter.

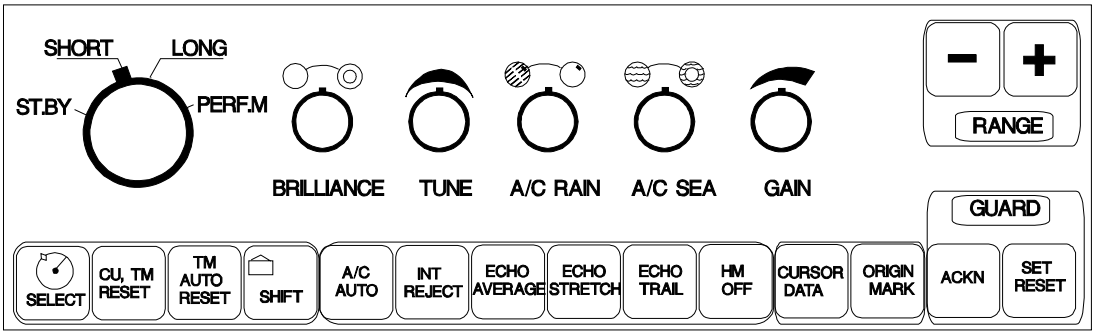


Figure 14. Control panel of the CITY OF SUNDERLAND's main radar. The panel is clear and easy to use.

The radar's adjustments were good ergonomically. Its image could be adjusted using the TUNE, A/C SEA (clutter reduction) and GAIN controls. These controls were arranged logically on the control panel so that they were not on top of each other. The radar had a 3 cm transmitter in accordance with the regulations, which is not the best possible wavelength if there is sea clutter on the radar. According to the information available, there was no technical malfunction of the radar itself (figure 15).

The master and the pilot had similar opinions about the radar image. According to the master, there was sea clutter on the radar image. He tried to reduce the clutter a few

[27] Starboard radar FURUNO FR-2022X-4A.

times after the release of the tug. The pilot said that the use of the radar had been non-existent. According to him, it is possible to adjust a radar under similar conditions, but he could not say if the vessel's radar had been technically fully-functional or not. On the other hand, the pilot also stated that under the conditions prevailing at the time, it would have been difficult to improve the image. The waves and the ice combined to produce uncommonly strong interference to the radar image. The master said that the visibility outside was non-existent.

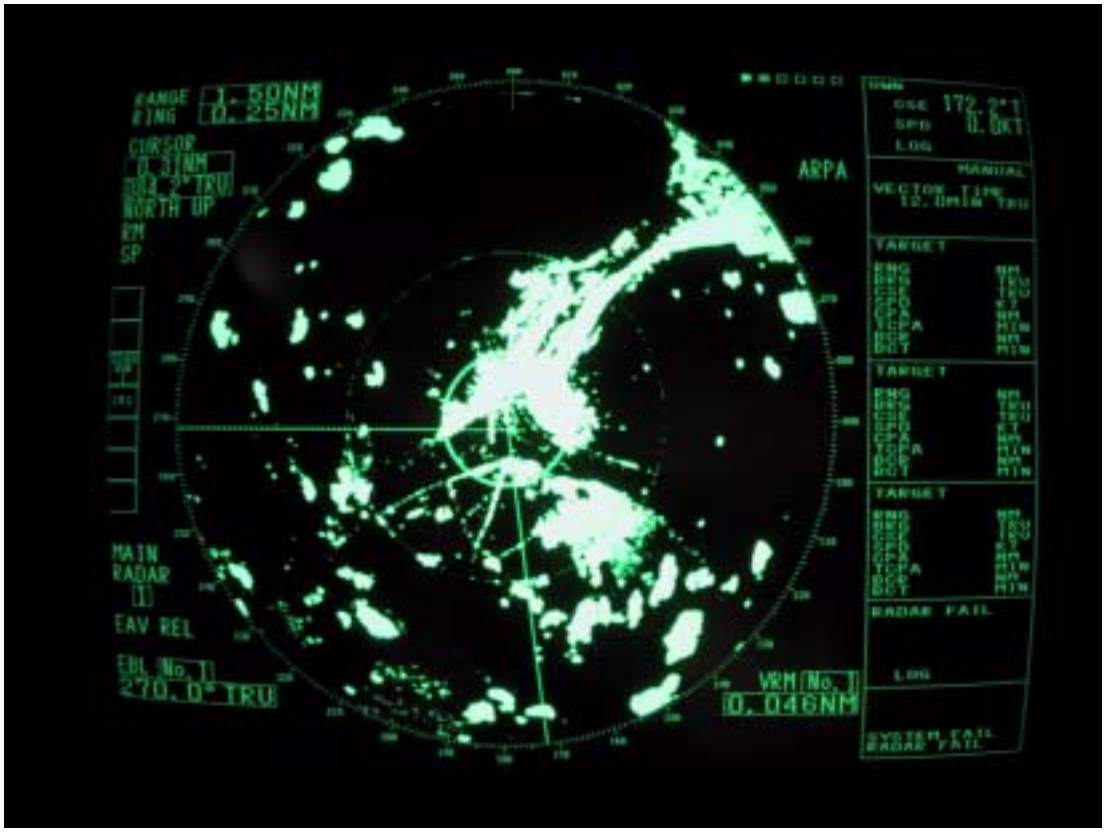
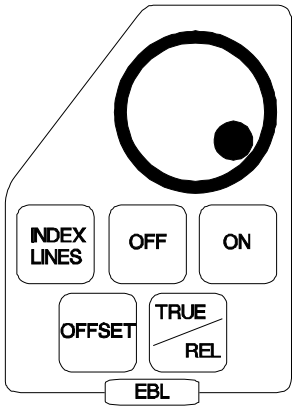
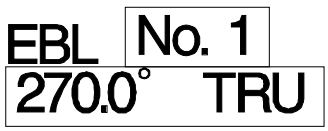


Figure 15. Image of the CITY OF SUNDERLAND's main radar at berth after the accident.





EBL:n numeerinen esitys tutkan vasemmassa alalaidassa.

The keyboard of the radar provided clear settings for EBL:
INDEX LINES = 'parallel index' lines.
OFFSET = setting to outside of one's own ship.
TRUE = true heading.

Figure 16. Radar bearing settings.

There was no mention in the Maritime Declaration of the radar's EBL having been used. After the tug's release, the true heading into the strait between Västertistro and Albertsklackarna was 121°. The CITY OF SUNDERLAND's course over ground, according to the VTS register, was about 137° (from 20:16:06 to 20:19:57). The vessel's compass headings according to the course plotter are presented in table 11.

Table 11. Approximate compass headings of the CITY OF SUNDERLAND before the grounding according to the course plotter.

UTC+2 from VTS image	**Heading**	**Observations of the investigation**
20.16.06	129°	VTS image
20.16.30	135°	Position interpolated from between the VTS images.
20.17.05	140°	VTS image
20.17.30	130°	Position interpolated from between the VTS images.
20.18.02	125°	VTS image
20.18.30	122°	Position interpolated from between the VTS images.
20.18.58	120°	VTS image
20.19.30	125°	Position interpolated from between the VTS images.
20.19.57	130°	VTS image

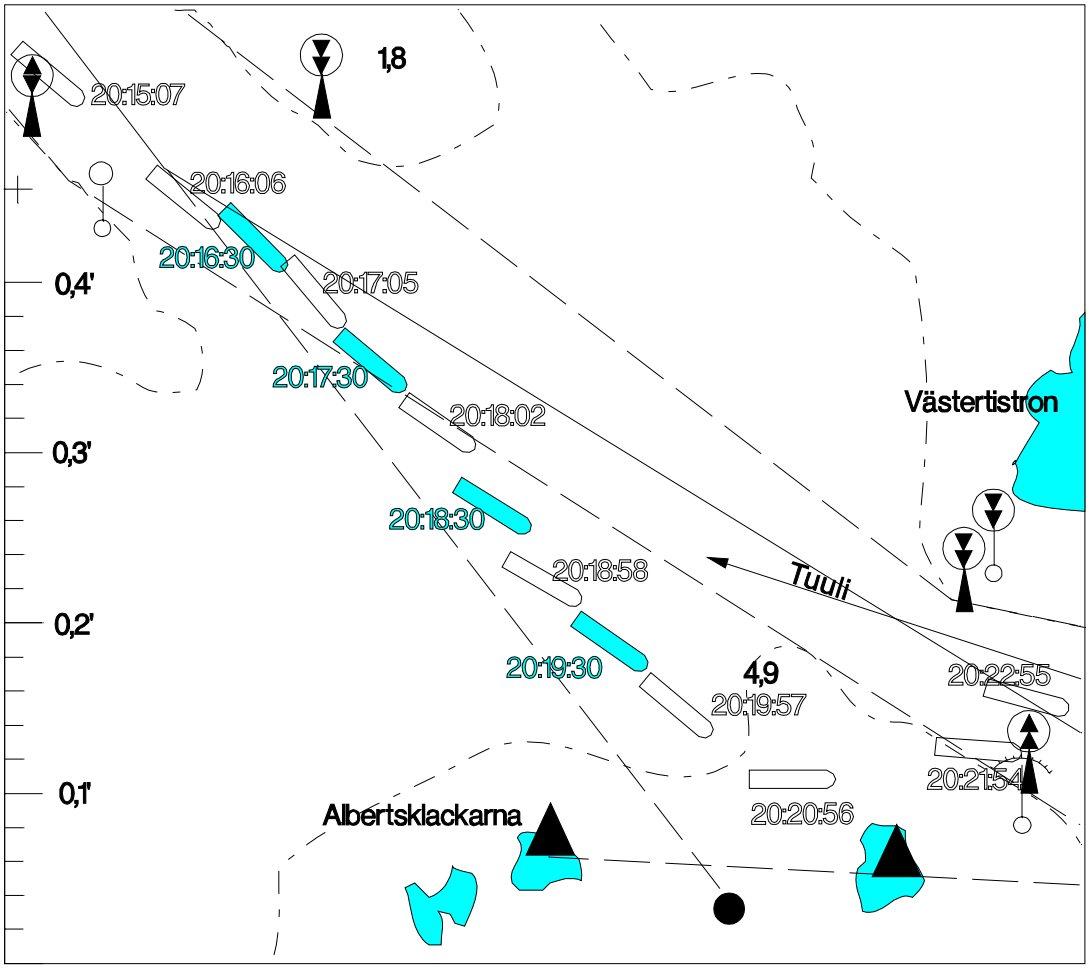


Figure 17. The compass heading used by the CITY OF SUNDERLAND indicates that it was difficult to determine the drift because of the poor radar image.

The drift angle of the vessel varied between 10° and 20°. The radar targets ahead easily give the wrong impression of the fairway markings if the radar image is poor. The poor radar image deprived the pilot of his last chance of determining the correct heading. The vessel's compass heading was 10°-15° too much to starboard. The vessel's direction agreed with the given line, but the drift was greater than expected.

After the towline's release, the AJAX's crew had problems fastening the tow hook in the high seas. This is why the AJAX's master failed to notice in time that the CITY OF SUNDERLAND was drifting too far to the right.

The average speed from the Granskär buoy gate (at 20:15:07, figure 11) to the lower lead of Albertsklackarna (at 20:20:56) was about 6.2 knots.

The pilot knew that the correct heading was 121°, but if visibility is non-existent and the radar image is misleading, dependence on one's memory of the correct bearing should not override the radar's generated image.

2.5 Evaluation of rescue activities

The rescue activities, and the measures taken to protect the environment in connection with the floating of the grounded vessel, were conducted in accordance with current directions and regulations.

3 CONCLUSIONS

The investigative material shows that when the master requested a pilot, he had no intention of using a tug. As the ship approached the pilot boarding point, the wind force had already increased to the vessel's limit, so a tug would have been necessary. When the pilot entered the ship, he asked if a tug had already been requested. This shows that the use of a tug was left up to the pilot to decide.

The master and the pilot did not discuss the wind limit. Keeping the traffic moving was the aim of both officers. It was not a question of conscious risk but of prevailing practice.

It can be concluded that the cause of the accident is linked to the lack of support that the master and the pilot received for their decision making. The information on board the vessel indicated that the wind limit had been exceeded. The pressure to keep the ship in traffic prevented the master from waiting either for the weather to improve or for daylight. He left the definition of the wind limit to the pilot. The pilotage organisation has also left the definition of the wind limit to the pilot. Pilotage is seen as a service profession, where the main aim is to keep traffic moving. No pilot wishes to cause delays to the traffic. In this situation the pilot felt that decisions had been passed on to him, and he did not wish to accept the responsibility for stopping the traffic.

3.1 Chain of events leading to the accident

The lack of a wind limit in this situation led to a chain of events in which several unexpected factors followed one another. This chain of events could not be broken.

- The vessel's wind limit was exceeded when it was decided to attempt her berthing. The ordering of one tug improved the situation only in the case of a steady average wind, but one tug was not enough to cope with the gusts of wind.
- There was ice in the harbour basin and the CITY OF SUNDERLAND's side was frozen, resulting in the tug not being able to maintain an effective pushing position.
- The berthing failed.
- The vessel drifted against one of the breakwater's fender piles, and she was at risk of damaging her propeller and rudder against the breakwater.
- The hazardous situation forced the vessel to leave port quickly.
- Because of the adverse weather conditions, the pilot had no other choice than to turn to starboard, to the south-west. He had to pilot on a difficult fairway. The choice of fairway was forced upon him by the weather conditions.
- The blizzard made visibility non-existent.
- The vessel had no proper searchlights. The searchlights were used to try and locate the markers, but without success. The tug's searchlight provided only momentary help.

- The AJAX's tow-hook release mechanism had frozen. The release of the towline was delayed.
- The image on the CITY OF SUNDERLAND's radar was filled with clutter caused by the waves and the ice. This clutter obliterated the fairway markers and small targets.
- Determination of the vessel's heading by radar was unsuccessful.

4 RECOMMENDATIONS

Car ferries are wind-prone. The master and the pilot were aware of this. The SOLAS convention demands operational limits for passenger ferries only. Car ferries are more sensitive to the wind, as they are equipped with steering propellers which are not as efficient as those of passenger ships. The International Safety Management (ISM) code stipulates that limitations or operational procedures be defined for all risk situations[28]. The International Maritime Organization (IMO) resolution is demanding, since it does not specify risk factors. The accident to the CITY OF SUNDERLAND proves that the definition of wind limits comes under the sphere of the ISM code. The need for defining the wind limit is based on the fact that the master needs support for his decisions.

Shipping companies with similar vessels could share the costs of commissioning wind tunnel studies and mathematical models. This kind of investment would be worthwhile in the quest for safety.

It is the recommendation of the investigation that:

1. *Shipping companies consider the definition of wind limits for the vessels in their safety management systems.*

Cooperation between the shipping companies and ports would be useful in defining wind currents in ports. Wind tunnel measurements have been conducted in several Finnish and Caribbean ports.

It is the recommendation of the investigation that:

2. *Port organisations commission a landscape model of their port areas and define the correction factors for the model in a wind tunnel.*

Helsinki, 26 November 2002.

Risto Repo Kari Larjo Kai Valonen

[28] IMO resolution A.741(18) par. 1.2.2.2 ' Safe management objectives of the Company should, inter alia:establish safeguards against all identified risks'.

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