Accident Investigation Board Norway

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REPORT MARINE 2014/06

REPORT ON MARINE ACCIDENT – NORTH TUG, LG7141 (NOR) AND OCEAN PRINCESS IMO NO 9187899 (BERMUDA) CAPSIZING AND SINKING IN KIRKENES, NORWAY, 10 JUNE 2013

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

Photo of ferry on the Norwegian west coast: Bente Amandussen

TABLE OF CONTENTS

NOTIFICATION OF THE ACCIDENT

On the evening of 10 June 2013, the Accident Investigation Board Norway (AIBN) was notified by the Joint Rescue Coordination Centre Northern Norway (JRCC-NN) that the workboat *North Tug* had capsized and sunk in Kirkenes. The accident had occurred in connection with *North Tug* assisting the cruise ship *Ocean Princess* during departure from the deepwater quay. No persons were physically injured in connection with the accident. The AIBN decided, in consultation with the Bermudan accident investigation authority, to conduct a joint investigation of the accident. The Norwegian Maritime Authority, local authorities and vessel owners were informed of the decision. Two marine casualty investigators travelled to Kirkenes and conducted interviews with the personnel involved. Two other marine casualty investigators travelled to Gravdal in Lofoten and conducted interviews with the crew of the cruise ship.

Figure 1: A red cross marks the position of 'North Tug' and 'Ocean Princess' at the time of the accident. Source: AIBN

Figure 2: The workboat 'North Tug' and the cruise ship 'Ocean Princess' on departure from Kirkenes on 10 June 2013. Photo: Private

SUMMARY

The workboat *North Tug* capsized and sank when it was assisting the cruise ship *Ocean Princess* during its departure from the quay in Kirkenes on 10 June 2013. The plan was to move the cruise ship sideways out from the quay, and *North Tug* was to assist in pulling the bow of the cruise ship away from the quay. There was a change of plan without this being communicated to the skipper of *North Tug*. This led to *North Tug* being pulled along by the cruise ship and moving backwards with the towline over its stern. This is a very unstable situation for a conventional tugboat with the towing point forward of the propellers. Because of the speed at which *North Tug* was moving astern, the aft deck started to fill up with water, which caused the boat to heel. *North Tug* ended up partly sideways on the direction of movement. The tug capsized as a consequence of water on deck and the transverse forces from the towline. Both crew members on board *North Tug* saved themselves by jumping into the water.

Currently, no mandatory requirements apply to the building and inspection of Norwegian tugboats with a length of less than 15 metres. Work is presently under way to put in place regulations that will ensure that workboats of less than 15 metres that are to carry out towing operations must meet specific requirements relating to intact stability and towing line attachment and release arrangements.

It is a basic operational condition for carrying out safe tugboat operations that the personnel involved have the necessary experience and work together as a team. Furthermore, it is essential that the communication between the vessel being assisted and the assisting vessel is adequate, accurate and understood by everyone involved. It is also necessary for the parties involved to be aware of the capacities and limitations of both the vessel to be assisted and the tugboat.

North Tug was not a certified tugboat, nor did the crew on board have experience of handling tonnages as big as *Ocean Princess*. None of the parties involved considered this to represent any particularly great risk. Nor did any of the parties involved conduct thorough risk assessments of the operation whereby the risks and potential undesirable incidents could have been identified and relevant risk-reduction measures implemented. The execution of the operation was therefore characterised by a lack of risk assessments and resulting inadequate planning and communication.

In that connection, safety recommendations are addressed to both vessel owners as well as to the Norwegian Coastal Administration (NCA).

1. FACTUAL INFORMATION

The factual information is based on interviews with the crews and owners of the vessels, interviews with the pilot and the NCA, technical investigations on board, a review of information from *Ocean Princess's* voyage data recorder (VDR), the JRCC-NN's action log, AIS data provided by the NCA, and information provided by the Norwegian Maritime Authority and local authorities in Kirkenes.

1.1 Details of the vessel and the accident

The vessel		
Name	*North Tug*	*Ocean Princess*
Flag state:	Norway	Bermuda
Class society	Unclassed	Bureau Veritas
IMO number / call signal	LG 7141	9187899/ZCDS4
Type	Workboat	Cruise ship
Build year	2012	1999
Owner	Dykknor AS, Kirkenes	Princess Cruises Ltd
Operator/ Responsible for ISM	Dykknor AS	Princess Cruises Ltd
Construction material	Aluminium	Steel
Length	14.89 m	181 m
Gross tonnage		30 277
The voyage		
Port of departure		Kirkenes
Type of voyage	Inshore	Coastal voyage
Cargo		Passengers
Persons on board	2	
Information about the accident		
Date and time	10 June 2013, 18:16 LT	
Type of accident	Capsizing/ sinking	
Place/position where the accident occurred	Coastal waters within the 12 nautical mile limit, Kirkenes port, N 69° 43.8, E 030°03.8	
Injuries/deaths	None	None
Damage to vessels/the environment	The vessel sank	
Vessel operation	During manoeuvring	
At what point of the vessel's voyage	Assisting in connection with departure	Departure
External environmental factors	Northeasterly wind 15–20 knots, relatively calm sea, daylight and good visibility	

1.2 Chain of events

The original plan was for the cruise ship *Ocean Princess* to drop anchor in Kirkenes harbour and transfer its passengers to shore by tender boat. Shortly before making the

call, however, the ship received a message from the agent stating that there was a free berth at the municipal deep-water quay. *Ocean Princess* arrived in Kirkenes and was moored in the morning of 10 June 2013. The ship had a pilot on board, and the workboat *North Tug* assisted in getting the hawsers ashore.

Ocean Princess was scheduled to depart from Kirkenes at 18:00 that same day. The pilot who was on board on arrival in the morning returned to the ship at approximately 17:00 to take part in the pre-departure briefing on the bridge. Because a rising northeasterly wind was blowing straight towards the quay, the captain decided that he wanted tugboat assistance in connection with the departure. There were no certified tugboats available in the harbour at the time. The pilot informed the captain that the only available resource was the workboat *North Tug*. Apart from the captain of *Ocean Princess* expressing the opinion that *North Tug* was small, the boat's capacities and limitations were not discussed further during the pre-departure briefing/departure planning.

After having assisted *Ocean Princess* in the morning, *North Tug* had towed two Russian trawlers during the day, but had completed the work at about 17:00. At approximately 17:15, the owners received an enquiry as to whether *North Tug* could take on the assignment of assisting *Ocean Princess* during its departing from the quay. The assignment was accepted. The general manager of Dykknor AS, the company that owns *North Tug*, contacted the skipper, and they boarded the tug together and started the engines. They then sailed to the deepwater quay, where they arrived at approximately 17:40. This was about 20 minutes before *Ocean Princess*'s scheduled departure. No risk assessment or safe job analysis was carried out prior to the operation. Based on the tug crew's understanding that the assignment was to pull the cruise ship straight out from the quay, they considered it to be a routine assignment. Nor did they perceive any particular risks that would suggest that they should decline the assignment.

The two crew members were to have the roles of deckman and skipper, respectively. Communication between *North Tug* and *Ocean Princess* was established on VHF channel 13 and was conducted in Norwegian throughout the operation.

The crew of *North Tug* had initially been told that the towline would be connected aft on *Ocean Princess*, but upon reaching the cruise ship, they were told to attach it on the forward port side.

A 72-mm towing hawser from *Ocean Princess* was lowered down to *North Tug*. The crew of *North Tug* were not happy with the length of hawser they received and requested that *Ocean Princess* pay out more hawser. This was done, and the hawser was paid out to a total length of around 70 metres. The crew of *North Tug* had planned to connect the towline from the cruise ship to its own towing wire, which was reeled onto the drum of the tug's towing winch. The dimension of the hawser that was lowered was too great for it to be shackled to their own wire. The hawser eye was therefore locked with a bolt in an arrangement above the towing winch (see Figure 3), without this being communicated to *Ocean Princess*. A knife, axe and sledgehammer lay ready next to the hawser's point of attachment so that it could be cut in the event of a critical situation. On board *Ocean Princess* the towing hawser was attached to one of the forward bollards. This meant that the towing hawser was locked at both ends. *North Tug* remained standby next to *Ocean Princess* awaiting orders from the pilot.

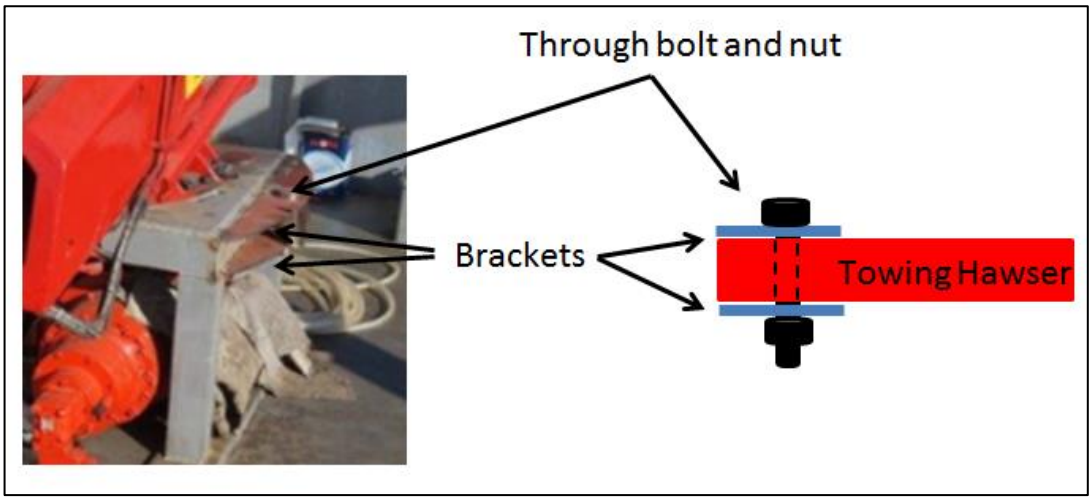

Figure 3: The photo on the left shows the fastening arrangement for the towing hook on board North Tug. The schematic drawing on the right shows how the eye of the towing hawser was locked to the fastening arrangement with a through bolt. Photo/illustration: Dykknor AS/AIBN

Originally, the captain on board *Ocean Princess* planned to connect *North Tug* at the stern for assistance with pulling the stern away from the quay. During the period from the pre-departure briefing until the arrival of *North Tug*, the plan was changed – *North Tug* was to be connected at the bow end. The idea was to use *North Tug* and the cruise ship's bow thrusters to pull the bow out, and to use the main engines and rudder to manoeuvre the stern away from the quay. The plan was to bring the cruise ship 50–70 metres out while keeping it parallel to the quay, and then pull the bow further to port and set the engines to go forward to put out of the harbour (see Figure 4). There was an easterly current at the time of departure.

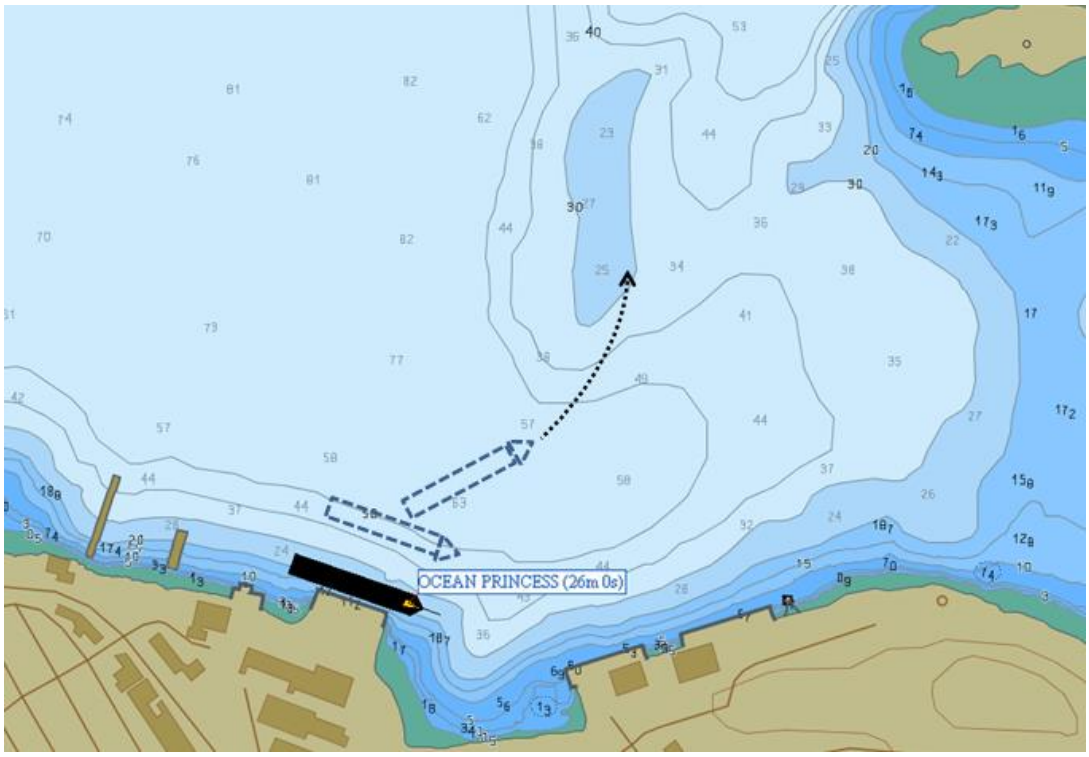

Figure 4: Schematic drawing showing the planned departure with 'North Tug' connected at the bow of 'Ocean Princess'. Source: NCA/AIBN

At 17:59, the work of manoeuvring the ship away from the quay started. During the departure, the following personnel were present on the bridge of *Ocean Princess*: The captain was in command and manoeuvring the ship. The staff captain assisted the captain and communicated with two of the ship's officers who manned the forward and aft mooring stations. The captain, staff captain and pilot were standing on the starboard bridge wing. The pilot was also inside on the bridge for brief periods. The first officer was inside on the bridge. The helmsman was manning the steering console on the bridge, and a lookout was standing on the port bridge wing.

It proved difficult to manoeuvre *Ocean Princess* away from the quay. The ship managed to put a distance of only 15–20 metres between itself and the quay, while moving approximately 30 metres forward (eastwards). About 9 minutes after starting the manoeuvre, the cruise ship's captain decided to change the original plan and let the bow move over to starboard, into the bay east of the deepwater quay, and then set the engines to go astern. The aim was to come clear of the piers that were located behind the cruise ship, where several fishing vessels were moored (see Figure 5). The manoeuvre was discussed with the pilot, and they agreed that it was a satisfactory plan. The change in the planned manoeuvre was not communicated to the skipper of *North Tug*.

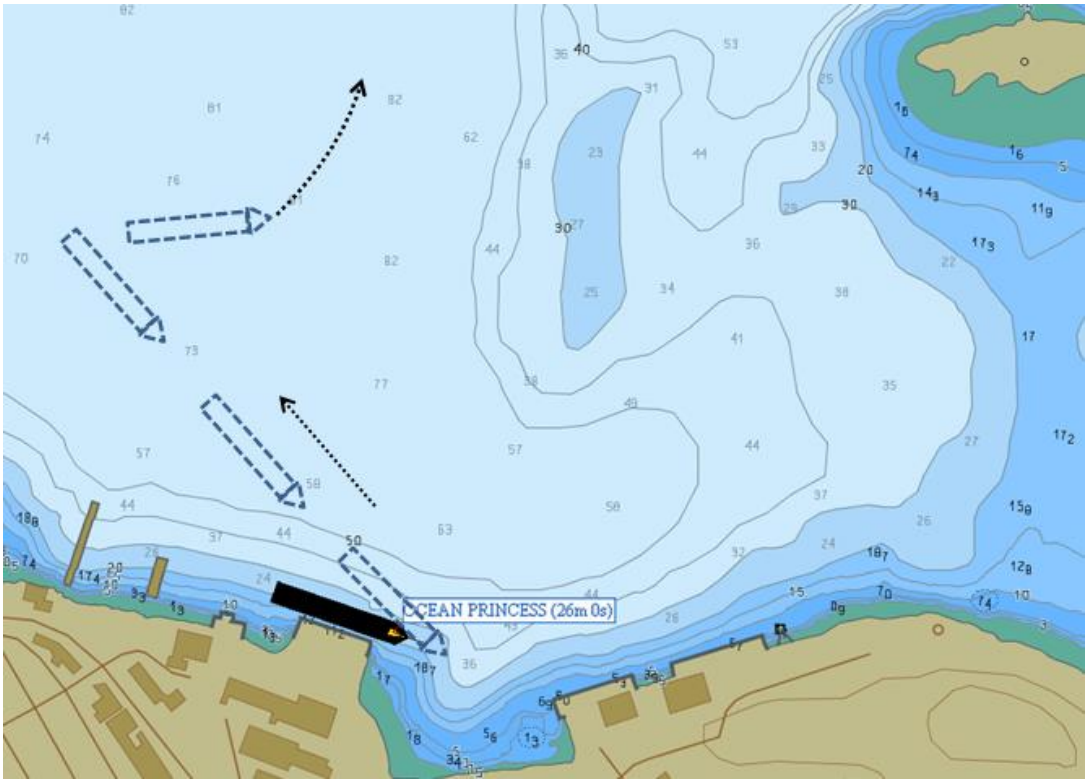

Figure 5: Schematic drawing showing the changed departure plan. Source: NCA/AIBN

At 18:11:30 *Ocean Princess* was at a sufficient angle to the deepwater quay, and both propellers were put in reverse. At that point in time, the cruise ship was moving astern at a speed of approximately 1.5 knots, and the speed was increasing rapidly. At 18:11:45, the captain told the pilot that *North Tug* should stop pulling.

At 18:11:50, the pilot asked *North Tug* to slack off the line. At the same time, *Ocean Princess* was accelerating astern and using the bow thrusters to push the bow towards the quay.

The skipper of *North Tug* reduced the engine speed and slacked the towing hawser. At 18:12:06, the skipper asked the pilot whether the towline should be disconnected.

The pilot requested that *North Tug* keep the towline fastened, as there was a possibility that assistance would be needed at a later stage of the operation. After a while, the skipper realised that *Ocean Princess* was moving astern. He therefore increased the engine speed forward and tried to turn *North Tug* over to port to move 'along with' the cruise ship, but the towing hawser became taut, causing the vessel to heel to port.

The engine speed was reduced once again and *North Tug* was pulled backwards by *Ocean Princess* and turned to starboard. *North Tug* put both engines in reverse to move astern and was able to follow the cruise ship. *Ocean Princess* further increased the speed at which it was moving astern. As a consequence, the aft deck on *North Tug* started to fill up with seawater. During this phase, the deckman of *North Tug* made two attempts to go aft to cut the towing hawser, but he was prevented from doing so by the water on the aft deck and the heeling of the tug. The skipper of *North Tug* did not inform *Ocean Princess* or the pilot about the problems they were experiencing in keeping up with the ship. None of those in charge on the bridge of *Ocean Princess* were in visual contact with *North Tug*.

The skipper of *North Tug* tried to set the engines to go forward again, but the starboard engine failed during this manoeuvre. This caused *North Tug* to turn sideways, which exposed it to strong transverse forces. At that point in time, *Ocean Princess* was moving astern at a speed through the water of approximately 4.5 knots.

At 18:14:13, the skipper of *North Tug* radioed the pilot and told him that one of the tugboat's engines had stopped and requested *Ocean Princess* to stop. The pilot did not understand what was said and asked for the message to be repeated. The skipper repeated the message 5 seconds later, but the pilot did not understand it this time either. Approximately 15–20 seconds after the first call was made, *North Tug* heeled over to starboard and capsized. According to the GPS positions, *Ocean Princess* moved approximately 285 metres astern from the moment when *North Tug* was asked to slack off until the boat capsized.

The two crew members on board *North Tug* jumped into the sea just before the tug capsized and swam ashore. At that time, there was nobody on board *Ocean Princess* who knew how many persons had been on board *North Tug*. This only became clear once the two crew members had come ashore.

When the captain of *Ocean Princess* became aware that *North Tug* had capsized, he reduced speed immediately and, a little while later, he gave the order to cut the towing hawser. As soon as the towing hawser had been cut, the captain manoeuvred the ship to a safe place and dropped anchor. After a period of floating in the capsized position, *North Tug's* stern sank below the surface. *North Tug* remained floating for a while longer, with just the bow sticking out of the water, before she sank at a depth of approximately 70 metres.

1.3 Weather and sea conditions

During the day, there had been rising winds from the northeast. During the period immediately before and immediately after *Ocean Princess's* departure from the deepwater quay, the wind was blowing directly abeam from port at an average speed of

15 knots (7.7 m/s), with gusts of up to 20 knots. The figure below shows an excerpt of wind data from *Ocean Princess*'s voyage data recorder (VDR).

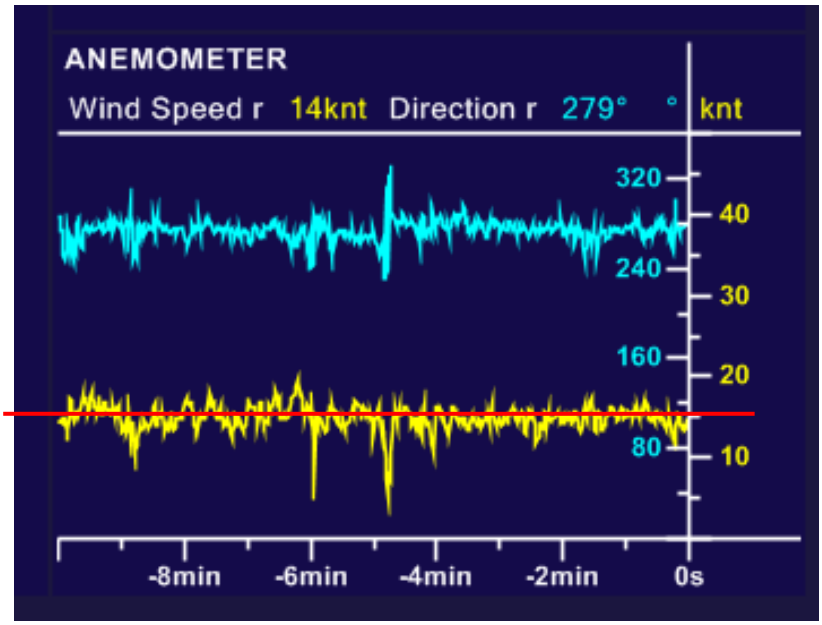

Figure 6 Excerpt of wind data from the VDR on board 'Ocean Princess'. Shows the relative wind speed and direction in the period from 17:57 to 18:07 LT. Source: Princess Cruises /AIBN

The Norwegian Meteorological Institute issued a weather forecast for Kirkenes at 12:00 local time (LT) on 10 June, indicating northeasterly breeze, sometimes increasing to fresh breeze, 10 m/s, and scattered showers. Another weather forecast was issued at 06:00 LT, indicating northerly breeze, sometimes increasing to fresh breeze, 10 m/s, and scattered showers. The wind force in the afternoon was thus in accordance with the forecasts.

1.4 The vessels

1.4.1 *North Tug*

North Tug was built in Turkey in 2012 and is owned by Dykknor AS in Kirkenes. The vessel is registered in the Norwegian Ordinary Ship Register (NOR) as a 'special-purpose vessel: small workboat' with a length overall of 14.892 metres, a breadth of 6 metres, and a normal draught of approximately 2.5 metres. *North Tug* is neither certified nor classed.

The hull of North Tug was based on a standard design from the build yard (Arya Multitug 0449). The owners wanted a multipurpose boat, and in the contract between the owners and the build yard, North Tug is described both as a 'twin screw multipurpose multitug workboat' and as a 'twin screw multipurpose workboat'. The interior and deck arrangement were designed by the owners themselves. The vessel is fitted with two 660-hp MAN main engines connected to two fixed propellers, and one bow thruster. North Tug's bollard pull is stated to be 18 tonnes, and the boat was fitted with a 30-tonne towing winch with a 60-metre wire. The winch on board North Tug had a local emergency release mechanism in the form of an arrangement attached to the winch itself, but had no mechanism for emergency release from the wheelhouse. The owners had ordered a towing hook, but it had not been received and was therefore not installed at the time of the accident.

Since *North Tug* was put into operation in spring 2013, its assignments had mainly consisted of towing fish-farming cages and feeding barges for the local aquaculture industry. It had also carried out several towing assignments towing trawlers to and from Kimek.

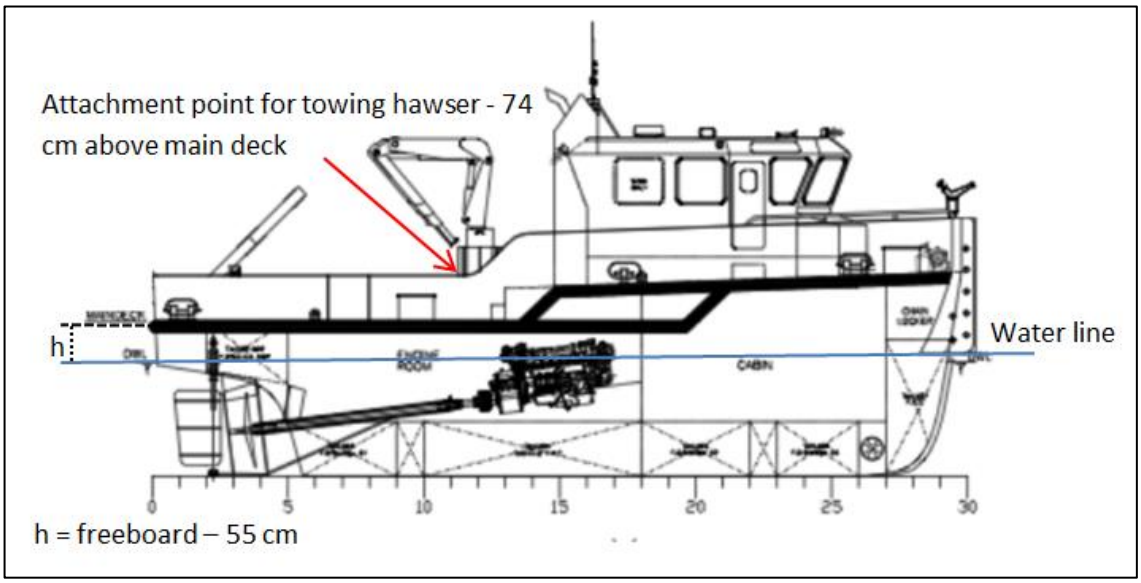

Figure 7: Schematic drawing showing 'North Tug' with indication of the height of the towing hawser's point of attachment and the stern freeboard. Source: Dykknor/AIBN

1.4.1.1 *North Tug's stability documentation*

North Tug had stability documentation from the build yard in the form of a 'Tug boat intact stability booklet' (in the following referred to as the Stability Booklet). According to the Stability Booklet, stability calculations had been carried out in accordance with IMO's [1] International Code on Intact Stability from 2008 (the IS Code). The AIBN has not carried out any control measurements or stability calculations for the vessel.

Calculations had been carried out for the following four load conditions:

- Light ship condition (not seagoing)
- Fully loaded departure (97.9%)
- Mid voyage (50%)
- Fully loaded arrival condition (10%)

According to the Stability Booklet, *North Tug* met all the IS Code's requirements for intact stability under all four above-mentioned load conditions (see the example in Figure 8). These requirements concur with the requirements that apply to Norwegian cargo vessels of more than 15 metres. The IS Code does not address the special requirements that apply to vessels to be used for towing.

[1] IMO: International Maritime Organization

Criteria	Value	Units	Actual	Status
Area 0 to 30				Pass
shall not be less than (>=)	0,055	m.rad	0,148	Pass
Area 0 to 40				Pass
shall not be less than (>=)	0,090	m.rad	0,219	Pass
Area 30 to 40				Pass
shall not be less than (>=)	0,030	m.rad	0,072	Pass
Max GZ at 30 or greater				Pass
shall not be less than (>=)	0,200	m	0,422	Pass
Angle of maximum GZ				Pass
shall not be less than (>=)	25,0	deg	30,0	Pass
Initial GMt				Pass
shall not be less than (>=)	0,150	m	1,442	Pass

Figure 8: The intact stability requirements set out in the IS Code compared with the applicable values for 'North Tug' in the 'fully loaded arrival' condition. Source: Dykknor AS

The documentation relating to the various load conditions states that the air inlets for the engine room on the starboard side and port side, respectively, are defined as the vessel's flooding points, and that they will be submerged at an angle of heel of between 46 and 51 degrees, depending on the load condition.

The Stability Booklet also contains 'Notes for the master' to provide decision-making support for the skipper. The document includes a general consideration of measures to prevent the vessel from capsizing. It is pointed out that the fact that a vessel meets the intact stability requirements is no guarantee against capsizing. The master is encouraged to practise good seamanship and take into account the season, weather forecasts and area of operations, and to adapt the course and speed to the prevailing conditions. (IS Code, Chapter 5.1 'General precautions against capsizing'). The 'Notes to the master' also deal with matters relating to the placement and stowing of cargo in relation to stability and the risk of cargo shifting (IS Code 5.1.2–5.1.3). These warnings are generally applicable to all cargo vessels.

As regards operations that include towing, such operations are briefly discussed in section 5.1.4 of the Code, where it is pointed out that a vessel engaged in towing operations must allow for sufficient reserve stability to withstand heeling moments from the towline. The section also points out that the towing vessel must have towing arrangements that allow for quick release of the towline. This section is not included in 'Notes for the master', however.

1.4.2 *Ocean Princess*

Ocean Princess was built in France in 1999 and is owned by Princess Cruises of California, USA. The vessel is classed by Bureau Veritas and sails under the Bermudan flag. *Ocean Princess* has a length overall of 181 metres, a breadth of 25.46 metres and a gross tonnage of 30,277. The vessel has four engines with a total output of 13,500 kW, two controllable pitch propellers, two independent spade rudders and two bow thrusters.

The shipboard engines are configured with constraints whereby, in manoeuvring mode, an output of 3,200 kW is normally available for manoeuvring using the two main propellers. In addition to this, an output of 1,500 kW is available for the bow thrusters.

By simultaneously switching from manoeuvring mode and stopping the bow thrusters, the output available for manoeuvring using the main propellers can be increased by 1,500 kW. More diesel generators can be started up, but this will not increase the output available for manoeuvring. These generators are redundant and meant to provide better safety in the event of a generator failing.

The vessel's Pilot Information Card states that there is an operational limitation in that at least one tugboat must be used at wind speeds of 22 knots (11.3 m/s) or more. At wind speeds of 35 knots (18 m/s) or more, at least two tugboats are required. However, there are no requirements for the tugboat's bollard pull or manoeuvring properties.

1.5 Operational conditions

1.5.1 Planning of the cruise ship's call at Kirkenes

1.5.1.1 *The owners' role*

At Princess Cruises, new cruise routes are planned by the company's sales department, while the operational part of the company (the Marine Department) deals with the safety aspect and carries out quality assurance of the voyage, ports, operations etc.

The Marine Department has developed Marine Port Assessment procedures used to assess relevant ports of call and checklists, Marine Port Assessment Form, as an aid to conducting such assessments. The checklists are meant to ensure that information is obtained about port agents, in addition to general information about the port, harbour master, quay inspections, alternative ports, anchorage options, pilotage services etc. As regards tugboats, information shall be entered in the Marine Port Assessment Form about the number of available tugboats, tugboat types, engine power and special comments, if any.

In connection with the planning of the call at Kirkenes, the owners contacted a Norwegian agent in January 2012, requesting practical information about the port of Kirkenes. The agent contacted Kirkenes Port Authority and asked for a list of tugboats, alternatively SAR vessels, in Kirkenes or nearby ports. The port authority replied to the enquiry and informed the agent that the port authority had a tugboat with a bollard pull of 20 tonnes. The port authority also informed the agent that both a SAR vessel and a pilot vessel were stationed in Kirkenes.

The owners planned for *Ocean Princess* to drop anchor at Kirkenes and for the passengers to be transferred to shore by tender boats. They did not, therefore, carry out a complete port assessment. The Port Information[2] document prepared for the captain of *Ocean Princess* on the basis of the information obtained by the owners states under 'Tug Information' that Kirkenes has a port tugboat with a bollard pull of 20 tonnes, without any further information about the type of tugboat. Kirkenes Port Authority's telephone number is entered as contact information for the tugboat. The port authority's tugboat was in dry dock at the time when *Ocean Princess* called.

The AIBN has had access to the owners' Port information documents for several Norwegian ports. Tugboat type is not specified for any of the other ports either. The tugboat information focuses on engine power and/or bollard pull only.

[2] Updated as of 25 January 2012.

1.5.1.2 *The role of the port authority*

In relation to *Ocean Princess's* call on 10 June 2013, the port authority only replied to one general enquiry, made by the vessel's Norwegian agent in January 2012. There was no contact between the port authority and the owners in connection with the further planning of the port call.

1.6 Vessel towing / manoeuvring in general

In this chapter, the AIBN will describe some relevant factors that influence the manoeuvrability and safety of tugboats during towing operations.

According to Henk Hensen's introduction to 'Tug use in port – a practical guide', experience, teamwork, communication and, not least, awareness of the capacities and limitations of both the vessel being assisted and the tugboat are all essential in order to carry out operations safely. According to H. Hensen, this applies to the skipper and crew of the tugboat as well as to the captain and pilot of the assisted vessel.

At present there are a number of different tugboat designs adapted to local conditions in individual ports and to the different vessel types that the tugboats are intended to assist. A number of methods for providing assistance to vessels have also been developed. For towing on a line, a distinction can be made between two types of tugboat: the conventional tugs on which the towing point is located forward of the propeller(s) and the tractor type on which the towing point is located aft of the propeller(s) (see Figure 9).

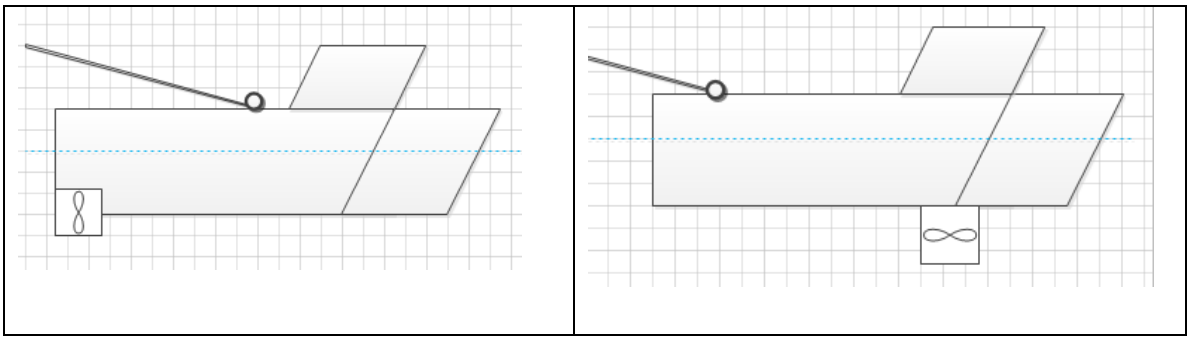

Figure 9: Schematic drawing of a conventional tugboat (on the left) and a tractor-type tug boat (on the right), both towing on a line. Source: AIBN

North Tug was built and registered as a workboat, but in connection with the accident in Kirkenes, the AIBN will treat the tug as a conventional tugboat with two propellers at the stern and with the towing point located close to midship. The towing method used was towing on a line. When *Ocean Princess* set the engines to go astern and *North Tug* was pulled along by the ship, the incident can be treated as if *North Tug* functioned as a 'stern tug'.

Conventional tugboats are used for all methods of towing, but these tugs have limitations when used as stern tugs[3]. When the vessel being assisted has a speed of more than 3 knots through the water, a conventional tugboat used as a stern tug can only operate along the side of the assisted vessel. With the towline attached at the point shown in the figure below, there is a risk that the tugboat will end up sideways on the direction of towing and be pulled over to the side.

[3] H. Hensen: 'Tug use in port – A practical guide'

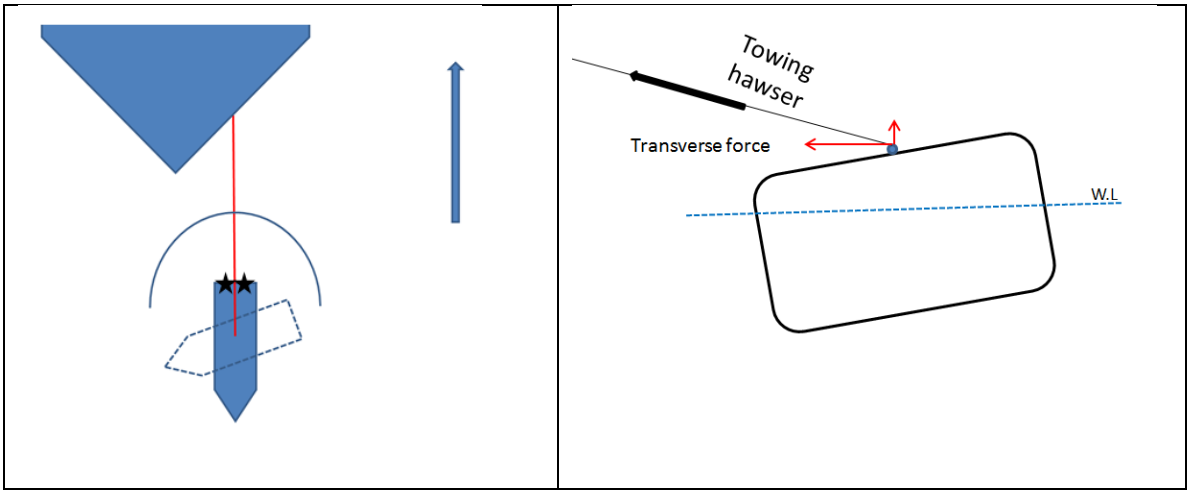

Figure 10: The schematic diagram on the left illustrates a situation in which the tugboat is being pulled along by the vessel to be assisted. Because of the position of the propellers in relation to the towing point, the tugboat is very vulnerable to the sideways pull. The schematic drawing on the right shows the tugboat seen from behind and illustrates how the forces exerted by the tug act on a vessel being pulled sideways. The vessel will also be exposed to several other forces. Source: AIBN

1.7 The crews

1.7.1 *North Tug*

North Tug had a crew of two: one skipper and one deckman. On the day in question, the owners' general manager was on deck while his brother was skipper. Both were experienced commercial divers with offshore experience from the North Sea. The skipper had completed a coastal skipper course, but was not formally certified as a navigator, nor was he required to hold such a certificate.

North Tug had arrived in Kirkenes towards the end of 2012, and started to operate in Kirkenes port in April 2013. During the period leading up to the accident, the two persons who were on board had carried out some light towing assignments towing local fish-farming cages and feeding rafts. On several occasions, they had also assisted in manoeuvring relatively small Russian trawlers out of and into the dock at Kimek. These operations involved objects that did not use their own engine power for manoeuvring. The crew had no experience of assisting vessels as large as *Ocean Princess*. The operation was also different from their previous operations in that *Ocean Princess* used its own engine power while manoeuvring out from the quay.

1.7.2 The bridge manning on *Ocean Princess*, including the pilot

The bridge procedures require the bridge to be manned to 'Bridge Manning Level – Red' during arrival and departure. Six persons are to be present on the bridge. During the departure from Kirkenes, the bridge was manned in accordance with these requirements. There were five members of the ship's crew in addition to the pilot.

The cruise ship's captain was 56 years old. He held an approved master's certificate and had seven years' experience as a cruise ship captain.

The staff captain was 44 years old. He held an approved master's certificate and had six years' experience as a staff captain.

The first officer was 38 years old. He held an approved master's certificate and had ten years' experience as a navigation officer with Princess Cruises.

In addition to the officers, the bridge was manned with a lookout and a helmsman, both of whom had extensive experience as crew on board cruise ships.

The pilot was 46 years old. He held an approved master's certificate and a pilot certificate for the fairway between Kirkenes and Lødingen. He had pilotage experience with cruise ships from both Kirkenes and Honningsvåg ports.

Most of his experience of using tugboats was from manoeuvring iron ore vessels in Kirkenes. Two hired Russian tugboats (tractor type) were normally used for that purpose, each with a bollard pull of around 60 tonnes. The pilot had some experience of using *North Tug*, but this experience was limited to uncomplicated assignments of towing relatively small Russian trawlers out of and into the dock at Kimek.

1.8 The owners

1.8.1 Dykknor AS

It is stated on Dykknor's website that the company has 10 years' experience from the North Sea and 20 years' experience of commercial diving, and that the company has also started taking towing/manoeuvring assignments. The company is owned by the two persons who were on board *North Tug* on the day of the accident. Each of them had previously been sole proprietor of his own commercial diving enterprise, until they bought another small workboat in 2010 and formed a limited company together. The workboat was primarily used for diving assignments. With the passage of time, the company found that there was also a demand for other services in the area, including towing, which eventually became part of their day-to-day operations. In autumn 2011, the company decided to have a new boat built, and *North Tug* was brought to Kirkenes at the end of November / beginning of December 2012.

1.8.2 Princess Cruises Ltd

Princess Cruises' webpage states that the company started operating with one ship in 1965. The company has grown to become the world's third largest cruise company, and today it operates a fleet of 17 modern cruise ships. Princess Cruises is owned by Carnival Corporation, one of the largest travel and tourism companies in the world.

1.9 The owners' safety management

1.9.1 Dykknor AS

The owners have established and documented their own HSE system for conducting diving operations. The system includes diving manuals based on the experience gained by the owners during their offshore work. According to the owners, a safe job analysis is always carried out before each new job. According to the owners, they planned to establish a corresponding system for towing assignments, but this work had not started at the time of the accident.

1.9.2 Princess Cruises Ltd

Princess Cruises' overall quality system is based on general quality principles, and broken down by activity area. The company's safety management system is based on the intentions set out in the International Safety Management (ISM) Code. 'Princess Cruises Fleet Regulations' is the main manual for the operational area. The company's detailed bridge procedures can be found in the special manual 'Deck Standing Orders'.

Some sections of the bridge procedures that may be relevant in relation to the accident in Kirkenes are listed below:

1.9.2.1 *Bridge resource management (BRM)*

Bridge Resource Management (BRM) is greatly emphasised in the procedure. The procedures describe who has operational authority and responsibility, who is involved in bridge operation, and how all parties must work as a team in order to avoid undesirable incidents. The BRM procedures deal with a number of factors relating to manning, tasks, work methods, how briefings should be conducted etc. The procedure emphasises that when a pilot communicates with external parties in a language other than English, the pilot shall be asked to communicate in English and/or translate what is being said for the bridge crew.

1.9.2.2 *Detailed Instructions for Working with the Pilot*

The detailed instructions focus on lines of command, division of responsibility and communication. It is explicitly stated in the introduction to the instructions that it is very important to inform the pilot that he will be cooperating with the navigator. The instructions refer to the 'Pilot Exchange Briefing Checklist', which, among other things, includes checkpoints relating to the pilot's role and position in relation to the activity. The checklist is divided into two parts: 'initial information' and 'topics to be discussed if relevant'. The initial information section deals with the ship's position, speed etc., VHF and radar, the presentation of a Pilot Card and asking the pilot if he thinks there are other things that require immediate attention.

Other relevant checkpoints include that mooring manoeuvres must be discussed in connection with departure and that there must be agreement concerning navigation and local limitations. The weather situation and any operations involving tugboats are also among the items that must be discussed.

1.9.2.3 *Detailed Instruction for Departure*

The bridge procedures contain 10 detailed sets of instructions on operations to be conducted in connection with departure, including the following:

'Departure briefing' with reference to 'Team Briefing Checklist' and 'Pilot Exchange Briefing Checklist'

'Detailed Instruction for Briefings' prescribe that a pre-departure briefing must be conducted and recommends that the pilot should be present. The captain shall conduct the departure briefing together with the bridge team (navigator, lookout and helmsman), the pilot and those in charge of the mooring stations. According to the 'Team Briefing Checklist', the captain shall go through and explain his plan for the departure, everything

that is expected of each of the respective functions involved, obtain confirmation of decision points and the emergency response plan, which tugboat is to be used and, in that connection, go through what is required of the tugboat, what type of towline will be used and the VHF channel to be used for communication. The 'Team Briefing Checklist' urges all participants in the briefing to put forward any comments, questions and proposals, and to express any doubts or concerns they may have.

1.9.2.4 *Closed Loop Communication*

In the chapter on communication, the system emphasises closed loop communication, a method of communication that is used to avoid misunderstandings. In practice, it means that the recipient is to repeat all orders and confirm that the order has been understood.

In the detailed instructions, the system describes a number of situations in which the use of closed loop communication is required, including between the bridge crew/officers and the pilot.

By way of conclusion, the instructions state that closed loop communication is a method used to avoid misunderstandings, but that it does not guarantee that no incidents or accidents can occur. It is therefore vitally important to always monitor how communication is actually carried out.

1.10 Relevant rules and regulations for cargo vessels of less than 15 metres

1.10.1 Draft new Regulations relating to the building and inspection of small cargo vessels

Currently, no mandatory requirements apply to the building and inspection of Norwegian tugboats with a length of less than 15 metres. However, on 1 July 2013, the Norwegian Maritime Authority distributed draft Regulations relating to the building and inspection of small cargo vessels for consultation with a deadline for submissions on 2 October 2013. Based on the consultation submissions, the Norwegian Maritime Authority distributed new draft Regulations for a consultation round with a deadline on 2 June 2014. The following is stated on the Norwegian Maritime Authority's website[4]:

> *The basis for the proposal is that, on several points, the existing regulations are inadequate and show signs of being old and inaccessible. New regulations relating to vessels of less than 24 metres are therefore among the items included in the Norwegian Maritime Authority's strategy plan for the period 2012–2015.*
>
> *The proposal concerns 'cargo vessels' and covers pilot boats, SAR vessels, small tugboats, aquaculture vessels, small wellboats and small cargo vessels etc. It also covers commercial vessels with a length of less than 24 metres that do not operate only as passenger vessels, fishing vessels or lighters. The number of vessels in the 'cargo vessel' category with a length of less than 24 metres that are currently in operation is uncertain, but the fleet is assumed to comprise between 1 000 and 1 200 active vessels. A large proportion (approx. 400–500) of these vessels serve the aquaculture industry. Most of the vessels (more than 80%) are less than 15 metres.*

[4] In connection with the distribution of the first draft for consultation

The draft new Regulations relating to the building and inspection of small cargo vessels set out a number of requirements. A selection of relevant requirements is cited in whole or in part below (unofficial translation):

Section 3 Definitions

For the purpose of these Regulations

(d) 'towing' shall mean towing or pushing of one or more objects

Section 13 Requirement for towing winch or towing hook when towing in the small coasting trade area or a smaller area

Vessels carrying out towing in the small coasting trade area or a smaller area shall have a towing winch or towing hook on board. The towing hook shall be attached so as to permit it to move freely within the relevant horizontal and vertical sectors that the towline can move through.

Section 15 Requirements for equipment and arrangements in connection with towing and anchor-handling in the small coasting trade area or smaller areas

(1) Vessels carrying out towing or anchor-handling operations in the small coasting trade area or a smaller area shall be subject to the requirements set out in paragraphs two to eleven.

(2) The winch, towing hook, guide pins and shark jaw shall have operationally reliable and expedient emergency release mechanisms.

(3) Emergency release must be possible

a) without manual intervention on or near the equipment

b) from the control panel for the equipment

c) from the relevant steering position on the vessel

d) in a dead ship situation

e) at the safe working load (SWL) for the equipment in question.

Section 16 Operational requirements in connection with towing in the small coasting trade area or smaller areas

(1) The towline shall be attached to a towing winch or towing hook.

Section 43 General requirements for intact stability

(1) All vessels shall have sufficient stability and preserve safe trim, so that listing is avoided in all relevant load conditions.

Section 44 Intact stability criteria for enclosed vessels

(1) For enclosed vessels, the following intact stability criteria must be satisfied in all load conditions when the cross-curves are calculated with free trim, unless otherwise provided for in Sections 46 to 48:

a) The area under the righting lever curve (GZ curve) shall not be less than 0.055 metre-radians up to 30º angle of heel and not less than 0.09 metre-radians

up to 40º angle of heel, or the angle of downflooding, if this angle is less than 40º. Furthermore, the area under the GZ curve between the angles of heel of 30º and 40º or between 30º and the angle of downflooding if this is less than 40º, shall not be less than 0.03 metre-radians

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

c) At the righting angle's maximum value (maximum GZ) the angle of heel shall not be less than 25º.

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

(2) When a vessel, on account of its hull shape, is unable to meet the criteria in (1)(c), (1)(a) and 1(c) may be replaced by the following:

The area under the GZ curve shall not be less than 0.07 metre-radians up to 15º angle of heel, when maximum GZ occurs at an angle of 15°, and 0.055 metre-radians up to 30º angle of heel, when maximum GZ occurs at an angle of 30º or above. Where the maximum GZ occurs at angles of between 15º and 30º, the required area under the GZ curve up to the angle at which the maximum GZ occurs shall be determined using the following equation:

Minimum area = 0.055 + 0.001 (30º – θ_{max}),

where θ_{max} is the angle at which maximum GZ occurs. Furthermore, the area under the GZ curve between the angles of 30º and 40º, or between 30º and the angle of downflooding if this is less than 40º, shall not be less than 0.03 metre-radians.

The angle of heel at which maximum GZ occurs shall not be less than 15º.

(3) For vessels delivered before 1 July 2015 with a length overall of less than 15 metres, Section Y3 of the Nordic Boat Standard may be complied with as an alternative to subsections (1) and (2) above.

Section 46 Additional intact stability requirement for vessels to be used for towing

(1) A vessel to be used for towing shall be an enclosed vessel.

(2) When a vessel while towing is exposed to a transverse force that causes the vessel to move at a speed athwart through the water of five knots, the first point of intersection between the heeling lever curve and the righting lever curve (GZ curve) shall occur at an angle that is smaller than the angle of downflooding.

(3) When a vessel while towing is exposed to a transverse force equal to the vessel's maximum bollard pull multiplied by 0.65, the area between the righting lever curve (GZ curve) and the heeling lever curve, calculated from the first point of intersection to whichever occurs first of an angle of 40º, the angle of maximum GZ and the angle of downflooding, shall be equal to or greater than 0.010 metre-radians. The vertical arm of the heeling moment shall be reckoned to extend from the centre of the propeller(s) to the towline's point of attachment.

Section 49 Freeboard for enclosed vessels

The freeboard shall be decided on the basis of stability, trim and hull strength etc., but must in no place and under no load condition be less than 200 mm from the top of the deck at the ship's side to the waterline

Provided that the Regulations enter into force, *North Tug* will be subject to the above requirements as from 1 July 2016.

1.10.2 Requirements for qualifications and personal certificates

The following is stated in Section 16 of the Norwegian Ship Safety and Security Act:

> *'Any person who is working on board must have the qualifications and certificates required for the relevant position or the work to be performed.'*

It is also stated that

> *'The Ministry may issue regulations containing further provisions relating to positions for which a certificate of competency is required and qualifications (...)'.*

Requirements for qualifications and certificates are set out in the Regulations of 22 December 2011 No 1523 concerning qualification requirements and certificate rights for personnel on board Norwegian ships (Regulations relating to Seafarers' Qualifications etc.). Pursuant to those Regulations, a deck officer's competence certificate is not required in order to fill the position of skipper, first mate or deck officer on cargo vessels of less than 15 metres.

In practice, this means that there are no specific official certificate requirements for crews on board vessels of *North Tug's* size. Pursuant to the Ship Safety and Security Act, it is up to the owners to define qualification requirements relating to commercial assignments carried out by this vessel type.

In February 2014, the Norwegian Maritime Authority started work on amending the Regulations of 22 December 2011 No 1523 concerning qualification requirements and certificate rights for personnel on board Norwegian ships (Regulations on Seafarers' Qualifications etc.). In that connection, the inclusion of qualification requirement for skippers on cargo vessels with a length overall of less than 15 metres is being considered.

1.10.3 Requirements for safety management

Section 7 of the Act of 16 February 2007 No 9 relating to Ship Safety And Security (the Ship Safety and Security Act) makes it mandatory for shipowners to establish a safety management system in connection with the operation of vessels. For workboats of *North Tug's* size, there are no further regulatory specifications.

1.11 The pilotage service

1.11.1 General information about the pilotage service

Pursuant to the Norwegian Pilotage Act[5], the NCA is responsible for Norway's pilotage services. The main objective of the pilotage service is to safeguard traffic at sea and protect the environment by providing necessary fairway knowledge to vessels' crews. By pilotage is meant guidance relating to vessels' navigation and manoeuvring. Pilots have a background as vessel masters or chief mates before they are recruited by the NCA. A pilot's certificate is issued to pilots pursuant to the Norwegian Pilotage Act. The Act does not in any way change the rules relating to the responsibility of the ship's master or of the officer of the watch as the master's deputy. The pilot is responsible for pilotage. The

[5] Act No 59 of 16 June 1989 relating to the Pilotage Service

ship’s master or the master's deputy in command may authorise the pilot to give orders on behalf of the vessel relating to its movement, navigation and manoeuvring. The pilot must clarify the working language for use in communication with the vessel traffic service centres and, if relevant, tugboat assistance, with the ship's master.

As regards the pilotage service, the NCA has divided the Norwegian coast into departments for maritime traffic. Kirkenes port falls under the Troms, Finnmark and Svalbard Department for Maritime Traffic. This department is headed by a pilot master/head of maritime traffic. There are 26 pilots affiliated to this department for maritime traffic. The pilots in the district are affiliated to permanent pilot stations, and Kirkenes port has three regular pilots. The pilot who was on board *Ocean Princess* is one of these three. The pilots are also certified for pilotage in other areas than those close to the pilot stations.

The following is an excerpt from the pilot's job description, section 8: *A state pilot is considered to be in the service of the vessel during pilotage. Pilotage entails no changes to the rules governing the responsibilities of the master of the vessel. During pilotage, the pilot shall give such advice and instructions as are required for the safe navigation and manoeuvring of the vessel.*

The following is stated in the NCA's instruction LOS 9.4 ‘Conducting pilotage’: *'The pilot shall give advice regarding the use of tugboats in cases where tugboat assistance does not follow from the navigation rules and other rules. If the master of the vessel fails to comply with the pilot's advice, or books tugboat capacity that does not meet applicable safety requirements, the pilot can demand to be excused from manoeuvring duties. The pilot shall nevertheless continue his/her pilotage assignment by remaining on the bridge and provide information and assistance to the ship's master.'*

1.11.2 Training in tugboat operations

The pilot training is described in a separate specification in the NCA's management system 'LOS 13.1.1 – Training curriculum for state pilots'. Pilot training consist of three levels.

- Level 1: 0–5 months (pilot training leading up to the first intermediate examination)
- Level 2: 5 months–3 years (pilot training leading up to a certificate covering the whole area and all tonnage categories)
- Level 3: 3–5 years:

One of the modules in level 1 of the training is a joint foundation course in vessel handling with emphasis on different vessel types and basic use of tugboats (an eight-hour course split equally between a theoretical part and practical training in manoeuvring). According to the curriculum, the vessel handling part of the course includes a tugboat course. The vessel handling training in level 2 includes a manned model course (ILAWA foundation course in Poland). This course includes training in the use of tugboats for big tonnages. The pilot who was on board *Ocean Princess* had completed levels 1 and 2 of the training programme.

Level 3 includes further training in vessel handling, but is reserved for pilots who wish to expand their certificate area or qualify for special operations.

1.12 Sør-Varanger port – Kirkenes

Kirkenes port has about 1,100 ship calls a year, mostly Russian trawlers. Approximately 28 ships a year call on Kirkenes in connection with ore export. These are vessels of 50–60,000 dwt. These vessels are manoeuvred to and away from the terminal with assistance from hired Russian tugboats. Kirkenes port had seven cruise ship calls in 2012, which increased to eight cruise ship calls in 2013. Kirkenes Port Authority allocates berths at the deepwater quay where *Ocean Princess* was moored.

Kirkenes Port Authority owns and operates the tugboat Kraft Johanssen, which is registered as an icebreaker/tugboat in the small coasting trade area. It has a gross tonnage of 197 and a 2250-hp main engine. During the period when *Ocean Princess* called at Kirkenes, the tugboat was undergoing a routine dry dock stay and was thus not available for assignments.

The following is quoted from the port regulations in force as from 1 January 2013:

> *'The administration can order a vessel to use a tugboat if this is necessary for safety reasons or due to consideration for other traffic.'*[6]

According to Section 39 of the Norwegian Harbour and Fairways Act, 'Right of use of harbours', owners and operators of harbours and port terminals can stipulate limitations in the right to call on ports because of considerations relating to safety, the environment and the fisheries industry. According to the port authority, cruise ships normally operate without using a tugboat, and if the use of tugboats or mooring vessels is a requirement, they are requested by the pilot on board, (according to the NCA's instruction 'Conducting pilotage' 'The pilot shall give advice regarding the use of tugboats in cases where tugboat assistance does not follow from the navigation rules and other rules)

1.13 Access to tugboats in Kirkenes – Finnmark county

When *Ocean Princess* was scheduled to leave the quay in Kirkenes and assistance was required, no certified tugboats with trained crews were available. According to the NCA, this situation is the norm in many places in Finnmark county. There is not sufficient activity in each port to warrant having bigger tugboat resources available. Not even Honningsvåg, which has over 100 cruise ship calls a year, has certified tugboat resources with trained crews available at all times. There, the local SAR vessel and pilot vessel are normally used for pushing[7] when assistance is needed in connection with cruise ship arrivals and departures.

Along the coast of Finnmark, there are currently only two places that have certified tugboats with trained crews available at all times: the gas terminal at Melkøya in Hammerfest and the tugboats involved in oil ship to ship transfer operations in the Sarnesfjord near Honningsvåg.

When vessels with a tonnage that makes tugboat assistance necessary call on the oil and gas terminals along the Norwegian coast, the terminals will normally have made plans and determined the tugboat requirements in advance. A few hours before the ship is due to call, the tugboat requirements are quality assured in relation to the prevailing wind and current conditions. The terminals often use pilots who are dedicated to and specially trained for the task of piloting heavy-tonnage vessels at the terminal in question. Usually,

[6] Sør-Varanger municipality, Kirkenes Port Authority, The Port Regulations 2013, 6.1.1.2 Chapter II. Mooring, stays in port etc. Section 2-4. Tugboat assistance

[7] Pushing: *North Tug* had a fendered bow and could have pushed Ocean Princess away from the quay.

the same tugboat resources are also used for all operations. This means that the dedicated pilots and tugboat skippers know each other and the procedures well.

Other than the resources linked to the terminals, the presence and availability of resources in each port when the need for a tugboat arises is more a matter of chance.

1.14 Implemented measures

1.14.1 Dykknor AS

According to Dykknor AS, *North Tug* has been put back into operation. The owners have imposed some restrictions on themselves as regards future towing assignments. For example, they have set a maximum limit of 300 GRT for towing on a line. The owners envisage that *North Tug* can assist in the towing of large-tonnage vessels, but only in cooperation with other tugboats and without connecting a towline.

All towing assignments must be reviewed together with the parties involved, and a safe job analysis must be carried out and signed. Any deviations from the planned execution, for example that the towed object uses its own engine power, loss of communication or other critical situations arising, shall result in immediate disconnection of the towline. The owners will focus on communication during towing operations and take the view that the language used should be one that allows all the parties involved to understand what is being said and done.

The owners have started work on an HSE binder/towing manual, and expect to complete it in summer 2014.

Before the accident occurred, Dykknor AS had ordered a towing hook for installation on board *North Tug*. The hook had not arrived at the time of the accident, but has subsequently been installed. The hook has an emergency release mechanism that can be operated both from the wheelhouse and from the work deck. The hook and emergency release mechanism is tested weekly, and will be tested before each towing assignment. The AIBN has not considered whether the towing hook meets the requirements set out in the draft Regulations for vessels of less than 15 metres or whether it meets the requirements in the Regulations for vessels of 15 metres or more.

The owners have implemented and plan to implement a number of measures. The AIBN will nevertheless make a recommendation to the owners concerning risk assessments in connection with towing operations.

2. ANALYSIS

2.1 Introduction

The analysis of the accident is based on facts obtained through interviews with those involved on board both vessels, meetings with the pilot, the NCA and the vessel owners, a review of data from *Ocean Princess's* VDR and the technical investigation.

The first part of the analysis, in section 2.2, reviews in more detail the chain of events when *Ocean Princess* left the quay assisted by *North Tug*. On the basis of that review, the AIBN has chosen to focus on the following areas:

- Section 2.3 considers the chain of events in connection with the capsizing and the immediate causes of the accident.
- Section 2.4 considers *North Tug* in relation to the regulatory framework for certified tugboats.
- Section 2.5 considers the contributory causes of the accident relating to the planning of the operation, focusing on risk management and the contributions of the different parties.
- Section 2.6 considers contributory causes relating to the actual execution of the operation, focusing on communication, experience and qualifications.

Just before *North Tug* capsized, the two crew members jumped overboard and swam towards the shore. Neither the crew nor the pilot on board *Ocean Princess* knew how many people there were on board *North Tug* to begin with. The AIBN has not analysed this factor further, but is of the opinion that it should be part of both the ship's and the pilot's procedures to obtain an overview of the number of crew members on board the assisting vessel(s).

Other relevant matters relating to this accident are whether the individual cruise port has sufficient infrastructure in place to receive large cruise ships and whether the port authorities make sufficient use of the provisions in the Fairways and Harbours Act that allow them to stipulate requirements for the vessels that call. However, the AIBN has decided not to look into these matters in its analysis of this accident.

2.2 Assessment of the chain of events

The original plan was for *Ocean Princess* to anchor in Kirkenes port, but the plan was changed and the vessel was moored at the quay. Due to rising winds on 10 June, a tugboat was needed in connection with *Ocean Princess's* departure. Despite the cruise ship call being planned well ahead, no certified tugboats were available on the afternoon in question.

The workboat *North Tug* was not a certified tugboat and the crew had no experience of handling vessels of *Ocean Princess's* size. In the AIBN's opinion, using such a vessel to assist a large cruise ship represents an increased risk compared with using a certified tugboat with a trained crew. This increased risk was neither identified during the planning of the departure nor during the pre-departure briefing on board *Ocean Princess*, despite assessment of tugboat requirements being among the elements included in the planning/briefing. Insufficient knowledge of *North Tug's* limitations is reflected in the planning and execution of the operation.

The decision to use a tugboat and the enquiry to *North Tug's* owners were made shortly before the cruise ship's scheduled departure. *North Tug's* owners accepted the assignment without making a thorough assessment of the risk it represented.

A heavy-duty towing hawser from *Ocean Princess* was used in connection with the departure. *North Tug* did not have the necessary equipment on board for connecting the towing hawser to its own towing wire, which was reeled onto the drum of the boat's towing winch. The towing hawser was therefore locked to the towing hook base on board *North Tug*, without the increased risk that this represented being communicated to those in charge on board *Ocean Princess*.

About nine minutes after the start of the manoeuvring away from the quay, the cruise ship's captain concluded that the planned manoeuvre whereby the cruise ship would be moved out while keeping it parallel to the quay did not work, despite the fact that the wind conditions were below the limits set by the shipping company for *Ocean Princess's* use of a tugboat and even though it was assisted by *North Tug* with its 18-tonne bollard pull. Princess Cruises should consider its requirements for when tugboats are to be used and look into how tugboats are used in relation to the vessel's own power.

When the captain concluded that the planned manoeuvre did not work, he discussed it with the pilot on board, and the plan was changed to letting the bow move over to starboard to get the stern at a good angle out from the quay and then set the engines to go astern. The 'new' plan was implemented 11 ½ minutes after the manoeuvring began. The change whereby the engines were set to go astern was not communicated to the crew of *North Tug*. A short while (15 seconds) after the manoeuvre started, *North Tug* was asked to slack off the line and keep the towline attached.

The astern manoeuvring resulted in *North Tug* rapidly turning to starboard and being pulled along by *Ocean Princess*, which quickly gained a speed of 4.8 knots astern. The AIBN deems this to have been the most critical point in the chain of events. *North Tug* went from being a conventional tugboat towing forward on a line over its stern to itself being pulled backwards by the towline over its stern.

When *North Tug* was pulled along by *Ocean Princess*, problems arose because the aft deck started to fill up with water. In the course of the approximately 1 ½ minutes that elapsed from the towline tightened until the boat capsized, the crew tried to handle the situation by reversing to follow *Ocean Princess* and attempting to release the towing hawser. They were prevented from cutting the towing hawser by the water on the aft deck and the boat heeling. The skipper did not inform the pilot or the captain on board *Ocean Princess* that they were in trouble before one of the boat's engines stopped and the course of events that led to its capsizing started. None of those in charge on the bridge of *Ocean Princess* were in visual contact with *North Tug*.

North Tug capsized extremely quickly, and the two people on board saved themselves by jumping into the sea. For a period after the vessel had capsized, the pilot and crew on board *Ocean Princess* were aware that two people had jumped into the sea, but they did not know how many crew members had been on board.

In the above, the AIBN has pointed out several factors that contributed to *North Tug* ending up in a situation where the boat was being pulled along by *Ocean Princess*, unable to free itself of the towline, and finally capsized. The AIBN believes these factors to be

related to lack of risk assessments, inadequate planning and inadequate communication. These matters will be discussed in more detail in the following sections.

2.3 Assessment of the chain of events during the capsizing

2.3.1 The capsizing

A conventional tugboat with aft propellers and the towing point forward of the propellers and speed astern is very likely to turn broadside when the towline is tightened (see Figure 10). This will expose the tugboat to strong transverse forces, placing it at risk of capsizing.

The situation changed rapidly when *North Tug* was instructed to slack off the line and keep the towline attached and *Ocean Princess* increased its speed astern without informing *North Tug*.

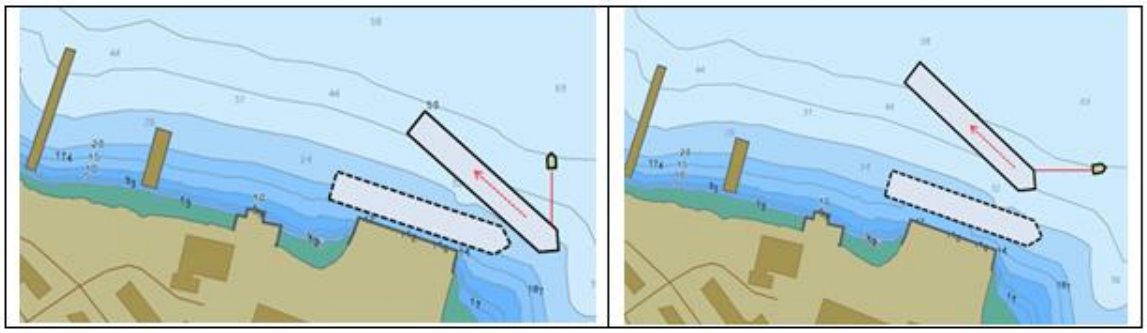

Figure 11: The schematic diagram illustrates Ocean Princess's astern movement. To begin with the towline went slack and 'North Tug' remained in virtually the same position until the towline became taut again, at which time it was in a forward angle in relation to 'Ocean Princess'. 'North Tug' was pulled along by 'Ocean Princess'. Source: NCA/AIBN

North Tug went from being a conventional tug towing on a line over its stern and thus having good manoeuvrability, to a situation where it was being pulled along, stern first, by *Ocean Princess*. This was a situation that it was impossible for the tugboat to manoeuvre out of.

The skipper of *North Tug* set both engines to go astern to follow *Ocean Princess*, but the increased speed caused the aft deck to start filling up with water. *North Tug's* open square stern and low freeboard made it possible for water to fill the deck (see Figure 12).

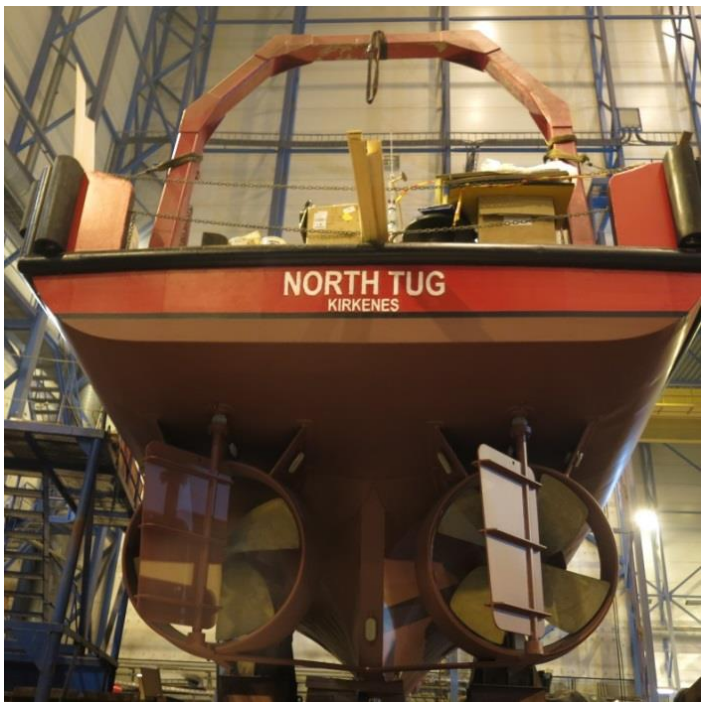

Figure 12: The photo shows the shape of the stern of 'North Tug'. The stern freeboard was about 0.55 metres. Photo: AIBN

The increasing amount of water on the aft deck contributed to reducing the boat's stability and probably caused heeling, which in turn increased the probability of the boat turning broadside. When the skipper finally understood that the situation was becoming serious, he tried to set both engines to forward. In connection with this manoeuvre, the starboard engine stopped.

The probable capsizing scenario is that *North Tug*, in what was already a very unstable situation, turned rapidly to starboard when one of its engines failed. When the boat turned to starboard and the towing hawser made contact with the A-frame at the stern of the boat, the point at which the force exerted by the towing hawser acted shifted abaft and upwards from the point where the towline was originally attached (see Figure 13). This increased the heeling and the speed with which water filled the deck. The amount of water on deck and the forces from the towing hawser caused *North Tug* to capsize.

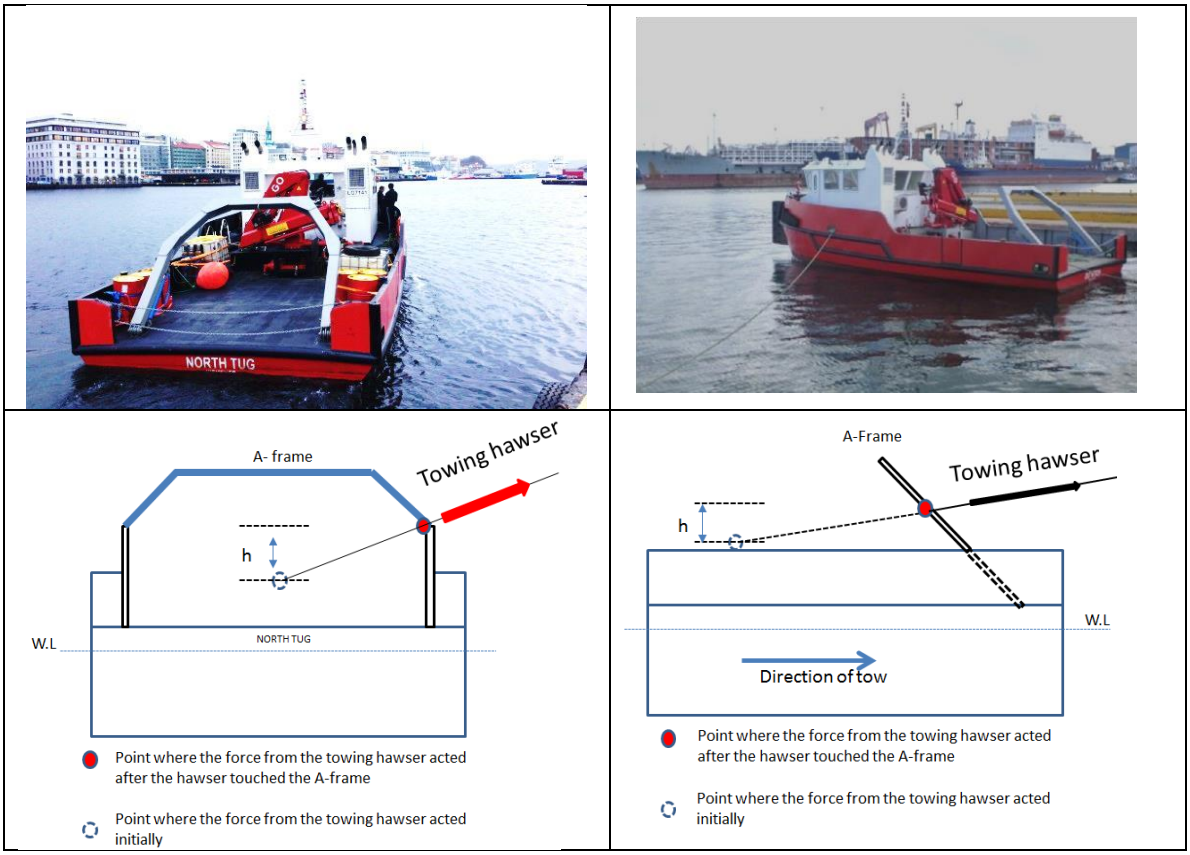

Figure 13: The schematic diagrams show how the point of action of the forces from the towline probably moved abaft and upwards when North Tug turned to starboard. Source: Dykknor AS/AIBN

The openings on the aft side of both the boat's smokestacks and the open door on the starboard side of the wheelhouse caused *North Tug's* buoyancy volumes to be filled with water, causing the boat to sink a few minutes after it heeled over.

North Tug capsized as a result of being subjected to heeling moments from the towline and water on deck that the boat did not have sufficient stability reserves to withstand.

2.3.2 Attachment of the towline

When *North Tug* arrived at *Ocean Princess* shortly before departure, a towing hawser was passed down from the cruise ship. The deckman on board *North Tug* wanted to shackle the hawser to *North Tug's* own towing wire, but had no shackles large enough. He therefore chose to lock the eye of the towing hawser to the base intended for fastening of the towing hook.

Although the boat's winch was not of the approved type allowing for emergency release from the wheelhouse, attaching the hawser to the winch would have made it possible to slacken the towline. In the early phase after *Ocean Princess* began to move astern, this could have allowed *North Tug* to manoeuvre into a position with the bow facing the direction of movement. Attaching the towline with a bolt allowed for no such possibility. The crew had placed an axe, sledgehammer and knife near the towing hawser's point of attachment, but the water filling the deck and the incipient heeling prevented the deckman from cutting the hawser when the situation became critical. The axe, sledgehammer and knife thus gave the crew a 'false' sense of safety that they could cut themselves loose should a critical situation arise.

It is always a risky operation to be connected to another vessel that is using its own engine power. Being connected without any real possibility of releasing the towline in an emergency increases the risk further.

2.4 Assessment of *North Tug* in relation to the requirements that apply to certified tugboats

At present, no official requirements apply to the use of workboats of less than 15 metres for operations like the one that was in progress when the accident happened in Kirkenes.

The basis for the intact stability requirements that apply to certified tugboats (15 metres or more) is the same as for cargo ships. It is the dynamic forces to which they are exposed during towing operations/from towlines that distinguish tugboats from ordinary cargo vessels. In order to address safety concerns in relation to these forces, tugboats of 15 metres or more are subject to extra intact stability requirements over and above the standard requirements that apply to cargo vessels.

According to the documentation from the build yard, *North Tug* was built in accordance with IMO IS 2008 (Intact Stability Code). A review of *North Tug's* Stability Booklet shows that the boat meets the international intact stability requirements for cargo ships, which correspond to the intact stability requirements set out in Norwegian regulations for cargo ships. IMO IS 2008 does not specifically require increased intact stability for vessels used to tow other vessels.

It is a key intact stability requirement in the Norwegian regulations[8] that apply to vessels over 15 metres used for towing that they must be able to withstand a transverse force producing a speed athwart through the water of five knots. The AIBN has not made its own stability calculations for *North Tug*, but notes that the vessel capsized and sank during an operation where the vessel was pulled partly athwart through the water at a speed of about 4.5 knots.

In addition to the stricter intact stability requirements, certified tugboats must also meet the requirements[9] relating to attachment and release arrangements for the towline, in the form of either an approved towing winch or an approved towing hook. The AIBN notes that *North Tug* did not meet these requirements.

In the AIBN's opinion, the intact stability requirement is intended to cover the worst-case scenario for a tugboat. However, the AIBN finds that while *North Tug* was moving (being pulled) astern at a speed of less than five knots, the aft deck started to fill up with water and the boat began to heel. The AIBN has not calculated the angle of heeling that the water filling the aft deck alone would have caused. The fact that the aft deck filled up with water as the boat was moving/being pulled astern suggests that priority may have been given to the development of the multipurpose design at the expense of properties that must be expected to be present in a tugboat.

[8] Regulations No 695 of 15 September 1992 relating to the construction of passenger ships, cargo vessels and lighters (Section 43)
[9] Regulations No 695 of 15 September 1992 relating to the construction of passenger ships, cargo vessels and lighters (Section 48)

Work is presently under way to put in place regulations that will ensure that workboats of less than 15 metres that are to carry out towing operations must meet specific intact requirements relating to stability and attachment and release arrangements.

In the AIBN's opinion, this accident clearly demonstrates the need to put regulations in place for workboats of less than 15 metres.

2.5 Risk assessments and planning of the operation

In general, there are risks associated with the execution of any towing operation. The regulations in place for tugboats over 15 metres ensure that tugboats have basic safety measures built in, among other things through laying down extra requirements for intact stability and release arrangements for the towline.

In the AIBN's opinion, using a vessel that is not a certified tugboat in a towing operation should entail a stronger focus on risk assessment and good understanding of the capacities and limitations such a vessel will represent during a towing operation. This must be reflected in the planning and execution of the operation.

2.5.1 Princess Cruises' planning of the port call in Kirkenes

As the plan was for *Ocean Princess* to drop anchor in Kirkenes, the shipping company did not carry out a complete Port Assessment. Information from the ship's Norwegian agent shows that the company nevertheless mapped local tugboat resources in winter 2012. Kirkenes port's tugboat was entered in the Port Information document later received by the captain of *Ocean Princess*. No quality assurance or updating of the information took place before the port call. Nor does the shipping company's safety management system include updating of information about available tugboat resources in advance of a port call, neither by the company nor by the vessel. As a result, the captain on board was not aware that the tugboat entered in the shipping company's information document was unavailable when, shortly before departure, the decision was made to use a tugboat.

In the AIBN's opinion, it is important for the captain on board to have an overview of the type of tugboat available so that the tugboat's capacities and limitations are known. The Port Information document that the shipping company provided the captain on board *Ocean Princess* with contained no information about what type of tugboat was available in Kirkenes.

In the AIBN's opinion, the lack of quality assurance of the availability of tugboats and the lacking overview of the type of tugboats, and thus their capacities and limitations, represent a weakness in the shipping company's planning of the port call.

2.5.2 The crew of *Ocean Princess's* risk assessment and planning of assistance during departure from the quay

Based on the wind conditions and the shipping company's guidelines for use of tugboats, the captain of *Ocean Princess* decided during the afternoon briefing that tugboat assistance was required. When the need for a tugboat arose in the afternoon of the day of the accident and the port authority's tugboat was in dry dock at the time, *North Tug* was the only available alternative for assisting *Ocean Princess* during its departure.

Using an uncertified work boat without having an overview of its possibilities and limitations should, in the AIBN's opinion, have caused the crew of the cruise ship to pause and make a thorough assessment of how this might affect the operation.

The shipping company's bridge procedures require the bridge crew and the pilot to conduct a pre-departure briefing in order to clarify requirements for the tugboat(s) and towline(s), among other things. As far as the AIBN has been able to ascertain, no assessment was carried out of the capacities and limitations of *North Tug*, neither in relation to how the operation was originally planned nor in relation to how it was executed after the plan was changed.

The plan was to manoeuvre *Ocean Princess* out while keeping it parallel to the quay, with *North Tug* operating a towline attached to the port side of the cruise ship's bow. No alternative manoeuvres or other uses of *North Tug* (for example hauling the cruise ship and pushing it from the starboard side) were considered.

In the AIBN's opinion, this represented a weakness in the risk assessment and planning on the part of the crew.

2.5.3 The pilot's contributions to the assessment and planning of assistance during departure from the quay

The pilot took part in the pre-departure briefing on the bridge shortly before departure. He only had experience of using *North Tug* for 'lighter' jobs, and did not fully understand the possible limitations of the boat or crew. The pilot considered the tugboat operation to be a matter between the captain of the cruise ship and the skipper of *North Tug*, where the pilot's role was to communicate the cruise ship captain's orders to the skipper of *North Tug*. However, the pilot assumed that when *North Tug* accepted the assignment of assisting *Ocean Princess*, it was sufficiently prepared and suitable for the job.

The AIBN interprets the NCA's instructions on 'Conducting pilotage' to mean that the pilot is to advise the captain on the use of tugboats and that the pilot should have an opinion about whether the tugboat meets the safety requirements. The pilots also undergo special training in tugboat operations. On this basis, the AIBN is of the opinion that the pilot should have assumed a more active role in the risk assessment of the operation in order to be able to provide the best possible advice to the crew about the planning and execution of the towing operation.

Although the pilot only has an advisory function, using an uncertified workboat without having an adequate overview of that vessel should, in the AIBN's opinion, have caused the pilot to pause and assess how this might affect the operation.

2.5.4 The shipping company/crew of *North Tug's* risk assessment and planning of assistance during departure from the quay

Dykknor AS had not established and documented a special HSE system for towing operations. The request to assist *Ocean Princess* on departure from the quay was made shortly before the cruise ship's scheduled time of departure, and concerned a type of assignment that the crew had no experience of. *North Tug* was also not a certified tugboat. The owners nonetheless chose to accept the assignment and did not communicate any limitations or uncertainty to the pilot on board *Ocean Princess.*

No risk assessment of the operation was carried out. In the AIBN's opinion, the reason for this was precisely their lack of necessary qualifications and experience of handling such tonnage, which caused them to not realise the risks involved.

A thorough risk assessment beforehand could have contributed to identifying the risks associated with the operation, thus ensuring the implementation of the necessary risk-reduction measures.

The crew on board *North Tug* were led to believe that the assignment was to pull *Ocean Princess* straight out from the quay. Their lack of experience caused the crew to deem this to be a simple operation without considering possible alternative manoeuvres.

Although the request for assistance was made shortly before the cruise ship's scheduled time of departure, the AIBN believes that Dykknor AS should in this case have taken the time to consider the operation in relation to their own safety. If they were not given time to do this, they should have declined the assignment or demanded that it be jointly planned.

2.5.5 Experience and qualifications

In the preceding sections, the AIBN has shown that the operation was characterised by inadequate risk assessment and planning. It is a prerequisite for carrying out good risk assessments and making good plans that the parties involved have sufficient experience and qualifications. At present, no official requirements for formal qualifications apply to the execution of tugboat operations.

The AIBN has not carried out any detailed assessment of the experience and qualifications of the different parties in relation to the execution of this towing operation. Nevertheless, the AIBN is of the opinion that the failure to identify risks and inadequate planning and execution suggests that none of the parties had the necessary understanding of *North Tug's* limitations in relation to the operation in question.

2.6 Communication

2.6.1 Communication on the bridge of *Ocean Princess*

Princess Cruiselines has a comprehensive safety management system, and the procedures that govern the work on the bridge have a clear focus on bridge resource management. For example, the procedures prescribe close cooperation between the bridge crew and pilot and focus on communication. The prescribed form of communication on the bridge is closed loop communication between personnel, with repeating of orders and confirmation that the content has been understood. By way of conclusion, the instructions state that closed loop communication is a technique intended to avoid misunderstanding, but that it does not guarantee that incidents or accidents will not happen. It is therefore vitally important to always monitor how communication is actually carried out.

The internal communication between members of the bridge crew of *Ocean Princess* and their communication with the pilot took place in English. The communication between the pilot and the skipper of *North Tug* took place in Norwegian. This made it impossible for the captain of *Ocean Princess* to quality assure this crucial part of the communication.

The shipping company has established procedures to ensure the best possible communication on the bridge, but these were not fully complied with during the departure from Kirkenes.

2.6.2 Communication between the pilot and the skipper of *North Tug*

The communication between the pilot and the skipper of *North Tug* took place in Norwegian. The AIBN sees that this has some advantages, including to ensure that no misunderstandings occur between the pilot and the skipper of *North Tug*.

The AIBN would nevertheless like to point out that when a choice is made to communicate in a language that is not understood by all parties involved, the pilot has a special responsibility for translating important information exchanged between the pilot and the tugboat for the captain of the ship.

The original plan for the departure was to move *Ocean Princess* away from the quay while keeping it parallel to the quay, but the plan was changed during the operation.

The change in plan, particularly the fact that *Ocean Princess* was to set its engines to go astern, was not communicated to *North Tug* before the manoeuvre was initiated. *North Tug* was told to slack off the line and keep the towline attached. At this time, the skipper of *North Tug* was not aware that *Ocean Princess* had set its engines to go astern and was accelerating. In the AIBN's opinion, it is crucial that the pilot inform the tugboat of the manoeuvres taking place at all times so that the tugboat can position itself safely in relation to the manoeuvring of the ship and avoid putting itself or being put in a dangerous situation.

The phase from *North Tug* started to be pulled along by the cruise ship until the tug capsized lasted approximately 1 ½ minutes, but the skipper did not communicate to those in charge of *Ocean Princess* that *North Tug* was experiencing problems. Also, none of those in charge on the bridge of *Ocean Princess* were in visual contact with *North Tug*. The skipper only asked *Ocean Princess* to stop after *North Tug's* starboard engine had stopped. By then, it was too late to prevent the boat from capsizing.

The skipper should have informed *Ocean Princess* that the operation was going wrong at an earlier stage. Also, he did not communicate to the pilot on board *Ocean Princess* beforehand that they were unable to connect the towline to their own winch, but had to lock the towline to the towing hook base.

The AIBN has not conducted further analysis of why the pilot did not communicate the change of plan and why the skipper did not communicate that they were experiencing problems. The AIBN would nevertheless like to point out that accurate and adequate communication between the ship and the tugboat is necessary to the safe execution or towing operations.

3. CONCLUSION

3.1 Chain of events

The accident in which the workboat *North Tug* capsized and sank took place in connection with a towing assignment when the cruise ship *Ocean Princess* was to leave Kirkenes. In connection with *Ocean Princess's* manoeuvring astern, *North Tug* was pulled along by the cruise ship at a speed of up to 4.8 knots.

Several factors contributed to *North Tug* ending up in this situation. The AIBN believes these factors to be related to lack of risk assessments, inadequate planning and inadequate communication.

3.2 The chain of events during the capsizing

North Tug capsized as a result of being subjected to heeling moments from the towline and water on deck that it did not have sufficient stability reserves to withstand. The accident was inevitable when *North Tug*, with the towline locked in place, was unable to get out of this situation.

3.3 *North Tug* seen in relation to the requirements for certified tugboats

It is a key intact stability requirement in the Norwegian regulations that apply to vessels over 15 metres used for towing that they must be able to withstand a transverse force producing a speed athwart through the water of five knots. The AIBN notes that *North Tug* capsized and sank during an operation where the vessel was pulled partly athwart through the water at a speed of about 4.5 knots.

In addition to the stricter intact stability requirements, certified tugboats must also meet the requirements relating to connection and release arrangements for the towline, in the form of either an approved towing winch or an approved towing hook. The AIBN notes that *North Tug* did not meet these requirements.

Work is presently under way to put in place regulations that will ensure that workboats of less than 15 metres that are to carry out towing operations must meet the requirements that apply to tugboats.

3.4 Risk assessments and planning of the operation

In the AIBN's opinion, the lack of quality assurance of the availability of tugboats and lack of overview of the type of tugboat, and thus their capacities and limitations, represent a weakness in the cruise ship company's overall planning of the port call.

The crew of *Ocean Princess* used a non-certified vessel, without having an overview of the limitations of the vessel and its crew. The risks involved and possible undesirable incidents were not identified or considered, neither during the planning of the departure nor during the pre-departure briefing. The lack of risk assessments led to inadequate planning of the operation and failure to implement sufficient risk-reduction measures.

Moreover, the pilot on board *Ocean Princess* did not have sufficient overview of the limitations of *North Tug* and its crew. Such an overview is a prerequisite for being able to provide the best possible advice to the crew of the cruise ship regarding the manoeuvring

away from the quay. Based on the above, the AIBN is of the opinion that the pilot should have assumed a more active role in the risk assessment of the operation.

North Tug's owners and crew had not established procedures necessary to carry out risk assessments. A thorough risk assessment beforehand could have contributed to identifying the risks associated with the operation, thus ensuring the implementation of the necessary risk-reduction measures. This could have prevented the accident. A risk assessment could also have resulted in the owners deciding to decline the assignment.

In that connection, safety recommendations are addressed to both vessel owners as well as to the NCA.

3.5 Communication

In the AIBN's opinion, there are several factors relating to the chain of events that required accurate and extensive communication. Examples include the increased risk associated with *North Tug* not being a certified tugboat, that *North Tug* had no possibility for emergency release of the towline should anything go wrong, that *North Tug's* crew lacked experience in handling heavy tonnage, and that the pilot lacked experience of using *North Tug* for this type of operation. The AIBN would also like to point out that there was no visual contact between those in charge on the bridge of *Ocean Princess* and *North Tug*.

In order to carry out towing operations as safely as possible, communication between the vessel being assisted and the assisting vessel must be adequate, accurate and understood by everyone involved. The crews of *Ocean Princess* and *North Tug* and the pilot should have ensured better communication before and during the accident.

4. SAFETY RECOMMENDATIONS

The investigation of this marine accident has identified the following areas in which the Accident Investigation Board Norway and the Department of Maritime Administration, Bermuda deems it necessary to submit safety recommendations for the purpose of improving safety at sea.[10]

Safety recommendation MARINE No 2014/09T

The shipping company's planning included a mapping of local tugboat resources well before the port call. The information obtained did not include tugboat type, and thus gave no indication of the tugboat's capacities and limitations. As a result, the captain on board did not have the necessary knowledge of the capacities and limitations of the planned tugboat. No quality assurance or updating of the information took place before the port call. As a result, the captain was also not aware that the planned tugboat was unavailable when, shortly before departure, the decision was made to use a tugboat.

Princess Cruises are recommended to ensure that the crews on board the company's vessels have a sufficient and up-to-date basis for planning operations that involve the use of tugboats.

Safety recommendation MARINE No 2014/10T

At the time of *Ocean Princess's* departure from Kirkenes, no certified tugboats with trained crews were available in Kirkenes. The crew on board used an uncertified workboat to assist the cruise ship during departure from the quay without having sufficient overview of the workboat's capacities and limitations. The risks associated with the operation were not mapped in advance. This resulted in inadequate planning, leading to the operation being executed in a manner that contributed to the workboat capsizing and sinking.

Princess Cruises are recommended to ensure that the crews on board the company's vessels have adequate procedures for carrying out risk assessments of operations that involve the use of tugboats. The crews' planning and execution of such operations must reflect the properties and limitations of the assisting vessel.

Safety recommendation MARINE No 2014/11T

One of the Norwegian Coastal Administration's pilots carried out the pilotage of *Ocean Princess*. During the departure, an uncertified workboat was used to assist *Ocean Princess* in moving away from the quay, without the pilot having sufficient overview of the workboat's capacities and limitations. The risks associated with the operation were not mapped in advance. Consequently, the pilot was unable to provide the best possible advice to the crew of the cruise ship regarding the manoeuvring away from the quay.

The Norwegian Coastal Administration is recommended to ensure that its pilots carry out thorough risk assessments of operations involving the use of tugboats in order to have a sufficient basis for contributing the advice and instructions necessary to the safe execution of the operation.

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

Safety recommendation MARINE No 2014/12T

The crew of *North Tug* did not carry out a risk assessment of the operation of assisting *Ocean Princess* during departure from the quay. A thorough risk assessment beforehand could have contributed to identifying the risks associated with the operation, thus ensuring the implementation of risk-reduction measures necessary to prevent the accident.

Dykknor AS is recommended to introduce procedures to ensure that risk assessments are carried out of towing operations and that the risks involved are considered in the planning and execution of the operations.

Accident Investigation Board Norway

Lillestrøm, 1 July 2014