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Report S 1998:02e

Collision between the Swedish vessel MT Tärnsjö and the Russian vessel MV Amur-2524 on 6 February 1998 at Strömskär, C county, Sweden
S-01/98

This is an English translation of the Swedish final report. If there are an discrepancies caused by the translation, the Swedish version is valid.

1998-12-23 S-01/98

National Maritime Administration

601 78 NORRKÖPING

Report S 1998:02

The Board of Accident Investigation (SHK) has investigated a collision that occurred on 6 February 1998 at Strömskär, C county, Sweden, between the Swedish vessel MT Tärnsjö and the Russian vessel MV Amur 2524.

In accordance with section 14 of the Ordinance on the Investigation of Accidents (1990:717) the Board herewith submits a report of the investigation.

S-E Sigfridsson

Hans Rosengren Per Lindemalm

Contents

Report S 1998:02e
S-01/98
Report completed 1998-12-23

Vessel, registration letters:	**A. MT Tärnsjö, SEOR** **B. MV Amur-2524, UJBS**
Owner/Operator:	**A.** Tärntank Rederi AB **B.** Western Shipping Co
Date and time of accident:	06-02-98 about 18.30 hrs (in darkness) (NB: All times given in Swedish Normal Time = UTC + 1 hour
Location:	Strömskär, C county, Sweden (pos 59°31',75N 16°59',10E)
Type of voyage:	**A.** In ballast Västerås-Södertälje **B.** Timber Tallinn-Köping
Weather and sea conditions	Calm, no swell, good visibility, air temperature -2-3°C, 25-30cm broken ice.
Numbers on board: crew:	**A.** 11 **B.** 12
passengers:	None.
Injuries:	None.
Damage to vessels:	**A.** Limited **B.** Extensive
Other damage:	None known.
Master's ages, certification:	**A.** 61 years, Swedish masters' certification, without limitation **B.** 38 years, Russian certification

The Board of Accident Investigation (SHK) was notified on 9 February 1998 that the Swedish vessel MT Tärnsjö and the Russian vessel MV Amur-2524 had collided at Strömskär, C county, on 6 February at about 18.30 hrs.

The accident has been investigated by the Board represented by S-E Sigfridsson, Chairman, Hans Rosengren, Chief Operational Investigator and Per Lindemalm, Chief Technical Investigator.

The investigation was followed by Sten Anderson of the Swedish Maritime Administration.

The Board investigates accidents and incidents from the point of view of safety. The purpose of the investigations is to prevent similar events from occurring in the future. The Board's investigations do not, however, have as their purpose to attribute guilt or liability.

SUMMARY

The product tanker Tärnsjö was proceeding in ballast from Västerås to Södertälje. The river vessel Amur-2524 was sailing from Tallinn to Köping with a cargo of timber. Both vessels had pilots on board.

As the vessels approached Hjulsta bridge, the pilots communicated and concluded that the vessels would meet in the Hjulsta Bends. In the area there was 25-30 cm unbroken ice. In the fairway the channel was open but covered with floes. It was dark but the visibility was good.

Several hundred metres west of Strömskär light, the ships collided, the Tärnsjö's bulbous bow penetrated the Amur-2524's port side. The Amur-2524 developed a list to port. The crew tried to run the vessel aground but could not make shallow water. They filled a starboard ballast tank to reduce the list. A tug arrived after a few hours to escort the Amur-2524 to Köping. During the voyage the vessel continued to sink by the bow so they determined to proceed to Västerås, which they reached on 7 February at 4.14 hrs. The vessel then had a list of about 5 degrees to port and a pronounced forward trim.

The cargo was discharged in Västerås and it was established that the Amur-2534 was seriously damaged. Following the examination, she was escorted to Stockholm, where she docked at GV Dock on 13 February. Repairs to the vessel took approximately four weeks.

The Tärnsjö continued to Hjulsta bridge after the collision. The crew investigated the damage, which was limited to a few minor indentations to her stem. She then continued her journey.

The immediate cause of the collision was that the meeting was poorly planned. Contributing factors were insufficient communication between the pilots, and that the resources available on the bridge were not used.

Recommendations

None.

1 FACTUAL INFORMATION

1.1 The Course of Events

This description of the course of events is taken from the testimonies of the officers and pilots on board the vessels. The testimonies agree in all essentials, and any discrepancies are pointed out in the text. Appendix 1 shows the fairway and the site of the accident.

The Tärnsjö's account of the journey until the collision

The product tanker Tärnsjö had unloaded oil products in Västerås and sailed for Södertälje in ballast on 6 February 1998 at 16.35 hrs. The master, BT, conned the vessel from the quay and then handed over to the pilot, LT. He then left the bridge.

On the bridge were the second officer, on watch, a relative of his and the pilot. The latter stood by the navigation radar, himself managing the vessel and radio communication until the collision occurred.

He was informed by the Södertälje traffic information centre of an oncoming vessel, the Amur-2524, which had left Södertälje at 13.47 hrs.

Lake Mälaren was icebound and the vessel followed the channel with floes at nearly full speed, 11-12 knots. She was initially on autopilot, but before they reached Toppvik the pilot switched to manual steering by depressing the control lever, thus taking over control from the autopilot.

They passed Kungsberget Shoal at 18.07 hrs and the Toppvik light at 18.15 hrs. At this time the pilot informed the Hjulsta bridge watch of Tärnsjö's position and estimated time of arrival. The watch responded that they would soon be opening the bridge for the Amur-2524, which was on the opposite course. The pilots aboard the two vessels then communicated and concluded they would meet in the Hjulsta Bends. However their statements differ somewhat as to what exactly was said and agreed upon regarding where they would meet.

The pilot slowed down just before rounding Agneudde. He turned the engine control to 5½ or 6, since the second officer informed him that this setting on the engine control levers was necessary to get any essential speed reduction. LT recollects seeing the log at 6 or 7 knots after they rounded Agneudde.

Once the pilot had reduced speed he requested they start two steering engines. The second officer did this. The rudder is usually manoeuvred by one steering engine. When quick rudder movements are required, the second steering engine is used to increase the flow to the rudder machinery.

As they passed Tedarudden and just before the pilot started the yaw round Tedarö light, he saw the lights of Amur-2524 above Kalvholmarna. He noted that she had not come as far as he had expected.

The pilot continued around Tedarö light with the same setting on the engine control lever. After the turn, the pilot asked if the bow thruster was running, to which the second officer replied negatively. The pilot requested that it be started and the second officer did this.

Starting the thruster takes a while. The first step is to push a button on the control panel at the conning position. The system then checks to see that there is enough power available. If not, another generator starts automatically and is phased into the network. This takes between thirty seconds and a minute. When power becomes available, a light on the control panel on the bridge lights and the thruster can be turned on by pushing a button.

The second officer states that power was not immediately available to start the thruster and so the system had to start another generator. One to one-and-a-half

minutes passed from the time the pilot requested that the thruster be started until it started rotating.

The pilot stated that once back on course after passing Tedarö light, he started to go astern by moving the engine control lever to Astern. He asked if he could go straight into full astern and the second officer confirmed this. He was under the impression that the machinery did not respond as expected since he did not feel any vibrations as he began to reverse the vessel. Both the second officer and the master state that they felt the hull vibrating as the tanker slowed.

The speed was reduced but Tärnsjö did not stop in time to prevent the collision with the Amur-2524. The Tärnsjö's stem struck the Amur-2524's port side at about 2 knots and penetrated the outer and inner plating at hold nr 2. The pilot stopped the Tärnsjö's main engine.

While reversing, the pilot did not touch the wheel and the tanker held a straight course. Prior to the collision, the stem began turning to port. The pilot tried to halt the turn with the bow thruster but did not notice any result.

After the vessels had come to a stop, they were stuck to each other for a while and then the Tärnsjö's stem slid out of the collision hole without assistance from the bridge. The Amur-2524 immediately had a list to port.

During the Tärnsjö's journey from Västerås, one of the radars was on. At the beginning of the Hjulsta Bends it was set to 0.75 M. The computer by the control position which shows the course and speed according to GPS was also switched on.

During the passage through the Hjulsta Bends the pilot used visual navigation only. Visibility was good. The fairway is well marked with beacons and the many islands disturbed the radar by blocking other vessels' echoes in the landscape. The pilot only looked at the computer occasionally. He does not remember observing the log it displayed except for the time he verified his speed reduction off Agneudde.

The master, BT, who handed over to the pilot after they left the quay in Västerås, was in his cabin when they approached the Hjulsta Bends. The cabin is located in the starboard forward part of the superstructure one deck below the bridge. The long forward cabin windows give a good view ahead. BT sat in the middle of the room in an armchair facing to port.

When the tanker rounded the Tedarö light, BT noticed the Amur-2524 ahead at a rather long distance on the starboard bow. He had the impression that she had stopped or was slowly moving through the icechannel. A moment later he noticed that the Amur-2524 was close and he immediately felt the vibrations of the Tärnsjö's hull. At about the same time the phone rang and he was called to the bridge by the second officer. BT hurried to the bridge and placed himself by the starboard front window but did not intervene. The Amur-2524 was then straight ahead and the collision occurred just seconds after BT arrived on the bridge.

BT was under the impression that the collision was minor and that Tärnsjö's stem had only done limited damage to the other ship. He thought the bulbous bow could have possibly pierced the side of Amur-2524 at half its length or at most three-quarters of its length. He did not think there was any damage to the Amur-2524's bulwarks.

On departure from Västerås the second officer was on watch on the bridge. At 18 hrs he was relieved by the chief officer. At that moment they were passing Hästskär. The second officer stayed on the bridge and discussed the cargo handling and cargo handling instruments with the chief officer. They were standing by the downward companionway from the bridge about two metres aft of the manoeuvre console where the pilot stood.

At about 18.05 hrs the chief officer received a telephone call from the owners. The call took between five and ten minutes and was over before they rounded Agneudde.

The chief- and second officers continued their conversation, interrupted on the occasions when the pilot requested that the steering engines and bow thruster be started and when he asked if the engine control lever could be put directly full astern. On both these occasions the second officer answered and carried out the request, even though the chief officer was on watch. LT thought the second officer was still on watch.

The second officer saw the lights from the Amur-2524 when he was starting the bow thruster after rounding Tedarö, but he cannot remember in what direction or at what distance.

When the pilot had ordered Full Astern and the hull began vibrating, the second officer used the phone on the conning desk to call BT to the bridge.

The chief officer confirms the second officer's statements about the course of events. He has said that he saw the Amur-2524's lights when Tärnsjö passed Tedarudden. He was under the impression that the Russian tanker was by the Hjulsta bridge.

There are discrepancies in the statements regarding the position at which the Tärnsjö began the astern manoeuvre. The pilot states that he began reversing as soon as they rounded Tedarö light. The second officer thought the reversing began just north of Kojviken. The chief officer does not know when the reversing began.

The forth person on the Tärnsjö's bridge stood forward by the bridge window to port during the events immediately preceding the collision. He was not blocking the pilot's view of the Amur-2524 or the fairway.

The Amur-2524's account of the journey until the collision

The Amur-2524 had loaded timber in Estonia and was on her way to Köping. The three holds were full of timber and timber was also piled on the hatches. The cargo did not correspond to full load, but the vessel was ballasted almost to her full draught.

She left Södertälje on 6 February at 13.47 after two pilots had boarded. The two pilots were on board to work in shifts since it was expected that the trip would take a long time considering the Amur-2524's weak engines and the icy channel.

On the bridge were the two pilots, LA1 and LA2, the helmsmen and the master, BA. At times the latter was in his cabin but he often went to the bridge.

On the Södertälje – Hjulsta bridge reach the ice was no real obstacle and the speed was approximately 5 knots. They passed Hälludden at 17.45 hrs. When the vessel was abeam Nybyholm at 18.12 hrs the pilot called Hjulsta bridge to confirm their arrival in approximately eight minutes. At the same time the Tärnsjö's pilot informed that they had passed Toppvik. The two vessels' pilots spoke to one another and concluded that they would meet at the Hjulsta Bends. They did not however agree upon any fixed place for the meeting.

The Amur-2524 passed Hjulsta bridge at 18.20. After the pilot thanked the Hjulsta bridge watch by radio for opening the bridge, the pilots on board each vessel spoke again and LA1 considers that they agreed the meeting would occur on the Tedarö light-Strömskär reach. LT does not remember that a place for the meeting was stated but declares that he expected the meeting to occur on the said reach.

The Amur-2524 continued along the ice channel. West of the bridge the ice was somewhat thicker. The pilot states that according to GPS their speed was approximately 4½ knots. When the vessel passed Korrknös light buoy, the pilot saw the

Tärnsjö's masthead lights over Kalvholmarna. He gained the impression that she had begun rounding Tedarö light to enter the reach to Strömskär. He noted that visibility was good.

At 18.25 hrs the Amur-2524 began rounding Strömskär. The Tärnsjö's hull was blocked by the islands of Strömskär and Kalvholmarna. When the Amur-2524 passed Strömskär's northern point and LA1 caught sight of the Tärnsjö's hull he was surprised she had come so far and was so close. He perceived that she had too much speed. He estimated that the meeting would occur in the bend west of the Strömskär light, located on the island's northern point.

LA1 called a warning to LT to the effect: "This isn't good. You must reverse." LT stated he had already reversed. The distance diminished quickly and LA1 called again and asked if LT had set Full Astern, which he confirmed.

At the site, the ice channel was approximately 50 metres wide and filled with broken ice; but there were no ice banks along the sides. The Amur-2524 was in the middle of the channel or slightly starboard of the centreline. LA1 tried to steer to starboard to make way for the Tärnsjö but without apparent effect. The ice prevented a quick evasive manoeuvre. At the last moment LA1 tried instead to turn to port to lessen the angle of impact but the ice prevented this as well. LA1 thought the Tärnsjö was in a port turn when the vessels collided.

LA1 stopped the main engine when the vessels collided and requested that LT do the same so the vessels could cling to one another.

According to LA1 the course of events took a minute from when he first saw the Tärnsjö's hull until the collision.

The pilot assisting aboard the Amur-2524, LA2, was on the bridge from when they passed the Hjulsta bridge until after the collision. His account is in accordance with LA1's. He added the following.

As far as he can remember, they received knowledge of the oncoming Tärnsjö at the same time as the Amur-2524 passed Oknö Hälludde, approximately three M east of Hjulsta bridge. At that point the pilots of the two vessels spoke but did not decide upon where they would meet. During the next conversation between the vessels when Amur-2524 passed Nybyholm, from what LA2 remembers, the pilots agreed upon where they would meet.

When they approached Strömskär LA2 was on the bridge's port side. While they were rounding the island he caught sight of the Tärnsjö and estimated the distance between the vessels to be 0.3-0.5 M (550-900 m). He thought the Tärnsjö could pass between the Amur-2524 and Strömskär, but the Tärnsjö was seen turning to port just before the collision.

The Amur-2524's master, BA, is a Russian citizen. His account was given through an interpreter. Parts of it were given in English which he understood well and spoke with some difficulty.

BA has called ports in Lake Mälaren several times and claims he knows the fairways well. The vessel was equipped with Swedish sea charts of the area.

BA said he was not informed that they were expecting to meet another vessel. LA1 states he was informed of the oncoming vessel already when the Amur-2524 was off Oknö Hälludde.

During the run from Södertälje, BA was in his cabin at times, but often visited the bridge. At 17.45 hrs he went to the bridge since they were approaching Hjulsta bridge, and relieved the chief officer who went below to have something to eat.

When they passed the bridge, BA states the speed was approximately 3½ knots and that there was approx. 25-35 cm of strong, thick ice. He noted that the visibility was good, 4-5 M. As the vessel slowly turned to port after passing the red

buoy, (Korrknös) the pilots spoke in Swedish. BA noticed no other vessel until Tärnsjö's hull appeared as the Amur-2524 rounded Strömskär.

BA confirms the pilots' account of the events just prior to the collision.

The Tärnsjö's account of the course of events following the collision

As mentioned, both vessels stopped and main engines were shut down. The vessels remained wedged together for a while. Statements regarding how long are vague, but it was probably some minutes. The Tärnsjö's bulbous bow then slid out of the hole in the Amur-2524's side without action from the former's bridge.

As soon as the vessels separated the Amur-2524 began heeling to port and ended with a list. Aboard the Tärnsjö searchlights were turned on to illuminate the Amur-2524's side, but only the upper edge of the plating and the upper part of the hole from the collision were visible. The Tärnsjö's chief officer went to the fore-castle and supervised the Tärnsjö's own damage inspection.

The pilots aboard both vessels spoke to each other and LT states that after a moment, "We're all right" was heard from the Amur-2524.

The Tärnsjö's master states he started the main engine and conned his ship away from the Amur-2524 and to the fendering off Hjulsta Bridge. BT states they left Amur-2524 approximately 10 minutes after the collision and according to the log they were moored at the bridge at 18.50 hrs.

After the forepeak tank had been emptied, it was inspected. Minor indentations to the bulbous bow and to the stem were found at a height that corresponds to the Amur-2524's stringer corners—the edge of the weather deck.

The inspection was completed and the Tärnsjö sailed under the bridge at 20.20 hrs bound for Södertälje.

The Amur-2524's account of the course of events following the collision

When the vessels separated, the Amur-2524 began to heel to port and ended up with a 10-12 degree list. The main engines were started and a grounding of the vessel was discussed. During this time the crew attempted to sound the tanks and holds, without gaining any clear idea of where the water was entering.

It was evident that ballast tank nr 7, where the collision occurred, was filled and that hold nr 2 was probably holed. In time it was noted that water had also entered the bow thruster room and the adjacent stores. The sounding of hold nr 1 indicated no sign of water, however it later became apparent that this hold had also gradually filled.

It was decided to fill ballast tank nr 10 to reduce the list, and a reduction to approximately 5 degrees was achieved.

The attempt to run the vessel aground on the east shore of Tedarön failed since her propulsion machinery was weak and the ice was too strong.

Instead assistance was summoned in the form of the tug Bore, and she arrived at 21 hrs. They proceeded at 21.05 hrs with Bore as icebreaker and escort. They advanced slowly and the vessel was sinking deeper by the bow.

On 7 February at 01.05 hrs the Amur-2524 stuck in the ice. After discussion on board between the Bore's officers and the Maritime Inspectorate, it was decided that the vessel would proceed to the closest harbour, Västerås. They arrived there at 04.15 hrs and the maritime inspector met and evaluated the situation. During the morninghours when alongside, the vessel continued to sink so they prepared to discharge the cargo in Västerås instead of in Köping.

Late on the night of 8 February the discharging was completed and it was concluded that approximately 150 tons of water had entered hold nr 1, that the hole in hold nr 2 was large, that double-bottom tank nr 6 had sprung a leak and

that water was entering several areas in the forebody including the bow thruster room.

After the inspection and temporary plugging of holes, the Amur-2524 was cleared to proceed to GV dock in Stockholm for repairs. The run was completed on 12 February, assisted by the Bore. The Amur-2524 docked at GV dock on 13 February.

The collision occurred at position N59°31´,7 E16°59´,1.

1.2 Injuries

No injuries were reported.

1.3 Damage to the Vessels

The Tärnsjö sustained minor indentations in the plating of the bulbous bow and in the stem slightly above the bulbous bow. Two indentations in the stem were noted by the classification society during the inspection. One approximately 20 mm deep was on the upper part of the bulbous bow approximately 4,5 metres above the keel at frame 179. The second, on the port side of the stem approximately 6,7 metres above the keel, was 30 cm deep.

In addition, paint was scraped off the bulbous bow in the area that had penetrated the other vessel. No leakage developed in the hull.

The Amur-2524 sustained extensive damage to her hull and equipment. The Board of Accident Investigation (SHK) inspected her in the GV dock on 14 February 1998 and documented the hull damage with photographs (appendix 2).

The Tärnsjö's bulbous bow collided with the Amur-2524's port side somewhat forward of amidships at frame 80. As the Amur-2524 continued to move forward the bulbous bow scraped and dented her plating and then penetrated through this at frame 86. The angle between the two vessels was approximately 60 degrees. The vessels continued to move past each other, whereupon the Amur-2524's plating was ripped up and bent together against the starboard side of the Tärnsjö's bow and quarter.

The Tärnsjö continued to move forwards and the tip of her bulbous bow penetrated the inner plating of the Amur-2524's hold nr 2 at frame 95.

The bottom of the bulb deformed the upper corner of the double-bottom tank. Accounts differ as to whether double-bottom tank nr 6 sprang a leak when its top edge was pressed in by the bottom of the bulbous bow.

From the shape and size of the hole in the inner plating it may be reckoned that the tip of the bulbous bow stopped approximately half a metre from the bulkhead separating holds nos 2 and 3.

Inside side tank no 7, which was pierced, web frames, frames and other stiffeners had been torn off and bent inwards onto the plating and hold side. In addition many ballast and secondary drains had been severed

The hole in the plating extended vertically from the underside of the bilge, i.e. the ship's bottom where it turns up to the side, up to the weather deck edge. This edge, the stringer corner, was sharply bent inboard at frame 94. The bulwark above was also bent inwards approx. 200 mm at the same place.

Via the ruptured secondary drains in side tank no 7, water penetrated hold nr 1, the bow thruster room and further to other spaces in the forebody. Here furnishings, stores and electrical apparatus were damaged. The electric motor of the bow thruster became submerged and was damaged. When a start was made on discharging the vessel in Västerås the water was nearly up to the level of the weather deck

in the forebody. When the cargo had been discharged there was about 150 tons of water in hold nr 1, which had presumably entered through a ruptured bilge drain-pipe.

The repairs took four weeks and nine tons of steel, and tens of metres of piping were replaced.

There is no report that the timber cargo was damaged, but costs arose since it was discharged at a different place from that contracted.

1.4 Other Damage

No known environmental damage or other damage.

1.5 The Crews

The Tärnsjö had a crew of ten, five of whom were officers.

The master was born in 1936 and holds Swedish certification for unrestricted trade area. He had worked for the owners for many years and at the time of the accident had been master of the Tärnsjö for two years.

The chief officer was born in 1961 and held Swedish certification for unrestricted trade area. He has sailed for many years as chief officer and had been with the owners for two years. At the time of the accident he had served aboard the Tärnsjö for three weeks.

The second officer was born 1971 and held Swedish officers' certification A A1B2. At the time of the accident he had served aboard the Tärnsjö for seven weeks.

The Amur-2524 had a crew of twelve, six of whom were officers.

The master is a Russian citizen born in 1959 and has served in the vessel for eight years, four as master.

The Tärnsjö's pilot was born 1951 and held Swedish masters' certification for unrestricted trade area.

The Amur-2524 pilots were born in 1947 and held masters' certification for unrestricted trade area.

All pilots held complete pilot certificates.

1.6 The Vessels

Tärnsjö, Appendix 3, is a modern product tanker built in 1993 at Kvaerner Klevens yard in Leirvik, Norway. She is owned by Tärntank Shipping Company AB, Donsö. The vessel is registered in Donsö, under the Swedish flag with the following data:

Length overall .	129.05 m
Length between pp	123.20 m
Beam, max	18.33 m
Depth, moulded	10.4 m
Draught, max	8.1 m
Dead weight	10 908 mton
Gross	6 534

The Tärnsjö's main engine, MAK type 9M 453C develops 3300 kW. The engine drives a variable-pitch propeller via a Renk reduction gear, which reduces engine

speed from 600 rpm to a propeller speed of 112.5 rpm. The propeller has strongly swept blades. Speed with full cargo is approximately 12 knots.

The machinery is controlled and monitored from the navigation bridge. The engine throttle is linked to a governor which, depending on the throttle setting, and engine and propeller load, combines engine speed and propeller pitch setting to optimise output without overloading. In rapid throttle changes, the governor will limit the speed at which engine and propeller settings are changed so as to avoid overload.

The rudder is of the Schilling type, with a maximum of 65 degrees of deflection to give extra good manoeuvrability, which is of special value at low speeds and in confined waters.

In the forebody there is an electrically driven bow thruster with an output of 700 kW. This is started and controlled from the bridge.

The vessel is built to Germanischer Lloyd class designation "+100A4,E2 (Oil tanker), +MC,AUT, propeller, propeller shaft, gear and rudder strengthened to 1A".

In addition, the vessel complies with Finnish/Swedish ice class 1B and, as appears from the class designation, her propellers, shaft, gearing and rudder are dimensioned for the high power requirements according to ice class 1A.

The vessel is built to meet the regulations of the Swedish Maritime Administration and other Swedish and international regulations required in the owners' operations.

The navigation bridge is well equipped with, inter alia, two radars, computer presentation of sea charts, radar images and information from e.g. gyrocompass, log and echo sounder. In addition there are two GPS receivers with DGPS function. The vessel has no course recorder or speed recorder.

The bridge is roomy with covered wings and almost all-round vision from the conning position. This is placed somewhat aft of the front and on the vessel's centreline. From the conning position the navigator can view and control all the essential instruments and has control levers and telephones within easy reach.

Port of the conning position there is a separate panel for loading and ballasting the vessel.

The engine room and superstructure are aft. The cargo compartment forward of this has a double bottom and double side plating. The space between the outer plating and the cargo tanks is taken up with ballast tanks. There are seven pairs of these separated by a central longitudinal bulkhead and six athwartships bulkheads.

In the bow there is a forepeak tank for ballast water. The lower part of this is formed by the space in the bulbous bow. This projects approximately 4 metres forward of where the stem meets the design waterline. The bulbous bow has an approximately oval cross-section. Two metres from its forward end this cross-section is about five metres high by about two metres broad. The bulb is solidly built with inner ring frames and heavy outer plating. Because of its convex form it can withstand great outer pressures.

At the time of the accident the Tärnsjö was sailing in ballast with a stern draught of 5.6m and a forward draught of 4.0m. Her displacement was approximately 8 000 tons.

On the bridge the result of the crash stop test is posted. This test is normally conducted in connection with the vessels pre-delivery trials. For tankers the test is usually carried out in full ballast condition. The weather should be calm and the water depth more than ten times the vessel's draught.

The protocol, which is given in graphic form in appendix 4, shows that when the vessel was sailing in ballast at full speed, 12.8 knots, and the engine control was

moved from full ahead to full astern, the Tärnsjö came to a standstill after 890 metres (approx. 0.5 M) and 3.2 mins.

In the crash stop manoeuvre, if the rudder is kept in its zero position, the protocol shows that the vessel turns to starboard while slowing and that her stem, in the two trials, ends up 70 m and 30 m, respectively, starboard of the original course line when she has come to a stop. This is because the Tärnsjö has a left-rotating propeller, both when sailing ahead and astern.

This tendency to turn may, however, be altered by the vessel's load condition, the water depth and other factors. It cannot always be relied on to occur.

The Amur-2524 (Appendix 5) is a Russian vessel built for general cargo, containers and bulk cargoes chiefly in the large rivers and coastal waters of the Baltic. The vessel was built in 1988 at the Zavody Tazkeho Strojarstva yard in Komarno, present-day Slovakia. She belongs to the Western Shipping Company, Kaliningrad. The vessel is registered in Kaliningrad under the Russian flag and has the following data:

Length overall	116,03 m
Length between pp	111,20 m
Beam, max	13,43 m
Depth, moulded	6,00 m
Draught	4,00 m
Dead weight	3 146 mton
Gross	3 086

The Amur-2524 has two Skoda main engines, type 6L275IIIPN, each coupled via reduction gears to a fixed-blade propeller. The engines together develop 1 030 kW. According to information in the register of shipping, speed with full load is 10 knots.

Aft of each propeller there is a rudder, and there is also a third rudder in the centreline furthest aft. In the forebody there is an electrically driven bow thruster. The vessel is built to comply with the regulations of the Russian classification society and lacks ice class.

The navigation bridge has built-in wings and a conventional arrangement of navigational instruments and manoeuvre controls. The equipment is sufficient to comply with international rules and the vessel has GPS, which is also used as a log.

The hull has a double bottom and double plating, which houses tanks for ballast and fuel. The bottom tanks do not communicate with the side tanks. The latter extend from the outer bottom to the weather deck and are 1 435 mm broad. They contain inter alia vertical ventilation channels to the holds, ballast conduits and secondary drains.

Inboard of the inner plating there are three holds with smooth inner sides. All stiffeners are inside the side tanks and the bottom tanks. The hydraulically operated cargo hatches extend the whole breadth of the holds.

In the forebody there is a forepeak for ballast, stores, exercise areas for the crew and the bow thruster room.

On inspection, the Board of Accident Investigation found that the dimensions of hull components such as web frames and other stiffeners were reasonable for the type of vessel and traffic. In addition rusting in the steel of the plating and stiffeners was negligible and on-site measurement showed that they retained their original dimensions according to the drawings.

At the time of the accident the Amur-2524 had a cargo of timber. The holds contained 1 618 cubic metres, with another approximately 600 cubic metres on the

hatches. In addition the vessel was ballasted and had a forward draught of 3.8 metres and an aft draught of 4.02 metres. This approximately corresponds to full dead weight.

1.7 Meteorological Information

The weather in the evening of 6 February was calm with good visibility, and the temperature was 2-3 below zero. There was no sea and the channel had 20-30 cm broken ice. The channel through the ice was covered with small floes. No ice banks had formed along the sides of the channel.

1.8 Medical Information

Nothing has emerged to indicate that the crew's or the pilot's mental or physical condition had been impaired prior to the accident.

2 ANALYSIS

2.1 The Place and Time of the Accident

According to concurring statements from the pilots and the crews, the accident took place approximately 100 m west or west north west of Strömskär's northern point. The collision was stated to have occurred at 18.28 or 18.30.

The Hjulsta Bends are shown in Appendix 1. West bound in the fairway one comes first to Hjulsta bridge. West of the bridge the fairway curves south. Strömskär's northern point lies approximately 0.7 M or 1 200 m west of the bridge. Past the bend there is a southward reach of approximately 1 000m. Between Märsön and Tedarön's southeastern point, the fairway bends approximately 100 degrees west and then there is another 1 000m reach to Agneudde. At Agneudde the fairway bends 90 degrees south and continues to Toppvik.

The middle of the fairway is 10-16 m deep but in places only 7-8 m. For vessels with a draught of 7 m the usable fairway width is some 200 m at the rounding of Strömskär, approximately 150 m in the narrowest part between Tedarö beacon and Märsön and approximately 170 m at Agneudde. The fairway is somewhat wider between the two turning points.

In the Hjulsta Bends the ice was broken. The fairway was, according to the pilots, approximately 50 metres wide in the area around Strömskär. There were no ice banks along the sides of the ice channel.

Along the reach between the Strömskär and Tedarö lights there are three low wooded islands to the east of the fairway. From the north they are in order, Strömskär, Lilla Kalvholmen and Stora Kalvholmen.

2.2 The Speeds of the Vessels

The Amur-2524 has weak engines and due to the ice was obliged maintain a steady and high output. Since her speed was low, she did not need to reduce output in the bends.

The Tärnsjö, a relatively powerful vessel and in ballast, had no difficulties maintaining normal speed in the prevailing ice conditions. Based on the times stated, her average speed between Hästskär and Toppvik was 11.5 knots.

Before Agneudde, the Tärnsjö's pilot states that he slowed down and kept this lower speed until he began reversing between Tedarö light and Strömskär.

The Amur-2524 passed Nybyholm at 18.12 hrs and arrived at the collision site 16 to 18 minutes later, depending on whether the collision occurred at 18.28 or 18.30. The stretch is approximately 1.5 M and the calculated average speed was 5.6 or 5.0 knots.

The accounts of the course of events show that the Tärnsjö passed Toppvik at about the same time that Amur-2524 passed Nybyholm. The distance between Toppvik and the collision site is approximately 2.8 M. Hence the Tärnsjö sailed about twice as far as Amur-2524. The Tärnsjö's average speed on the stretch thus becomes 10.5 or 9.4 knots.

The pilots aboard the Amur-2524 stated they saw the Tärnsjö's lights above Kalvholmarna when the Amur-2524 passed the Korrknös light buoy. They thought she had begun rounding Tedarö light. At that position the Amur-2524 was approximately 0.3 M from the collision site and the Tärnsjö was 0.65-0.7 M.

According to the pilots and the master, the Amur-2524's speed was between 3.5 and 4.5 knots. Taking this into account, Tärnsjö's average speed on the stretch from just south of Tedarö light to the collision site becomes between 7.6 and 9.7 knots. Toward the end of the stretch, her speed was reduced by the reversing and was approximately 2 knots at the collision. This means that her speed during the first part of the stretch must have been above the average.

Taking the lower average speed of 7.6 knots and assuming the full astern manoeuvre was somewhat hampered by the ice and therefore began 0.3 M before the collision site, then the Tärnsjö's speed before reversing becomes 10 knots.

If one assumes instead that the reversing was fully effective as in the emergency stopping trial, then the same calculation gives a speed just before the reversing of close to 10 knots.

Against this background the Board considers that Tärnsjö's speed when entering the yaw off Tedarö light must have been considerably greater than the 6-7 knots stated by the pilot.

The Board have found nothing to show that the reversing procedure was essentially less effective than what the emergency stopping trial shows. The reversing procedure was probably initiated too late. This in combination with the high speed resulted in the vessel being impossible to stop before the collision.

2.3 Communication between the Vessels

According to the pilots, they spoke to each other on two occasions and the meeting was discussed on both. On the first occasion the Amur-2524 was at Nybyholm and the Tärnsjö at Toppvik. During the second conversation, the Amur-2524 had just passed Hjulsta bridge. From then on they did not communicate nor give any information regarding positions or speeds; neither did they agree upon how they would handle the meeting, in other words, at what speed they would meet or if one vessel should heave to.

2.4 The Officers on Watch

On the bridge were the Tärnsjö's chief officer, who had come on watch at 18.00, and the second officer. They did not participate in the navigation nor did they follow what was happening other than temporarily during the passage through

the Hjulsta bends. The chief officer, on watch, was busy with a telephone call for 5-10 minutes. Both are unsure of the vessel's speed and of when and where the reversing procedure was initiated. Neither spoke with the pilot of his intentions concerning how or where the meeting with the other vessel would take place.

The second officer started two steering engines and the bow thruster at the pilot's request. The pilot was not aware that the second officer was no longer on duty.

On the Amur-2524's bridge were the pilots, the helmsmen and the master. The latter did not participate in the navigation and handed over to the pilot. The master had not received information of an approaching vessel nor did he inquire about such matters.

2.5 The Accident

The immediate cause of the collision was that the meeting was poorly planned. This in turn was mainly due to faulty communication between the pilots regarding how and where the meeting would take place. The Board however is obliged to note a circumstance that it has had reason to mention in several previous investigations; that is, the tendency that vessels with a pilot on board are conned by the pilot alone without use of the other resources available on the bridge. The accident could have had far worse consequences had the Tärnsjö's stem collided with the Amur-2524 a little further aft and also penetrated the athwartships bulkhead to hold nr 3. If this had happened Amur-2524 would probably have capsized and sunk.

The Board has not had access to the Amur-2524's stability data under the relevant load conditions and has been unable to perform a complete investigation of the vessel's stability and buoyancy in its damaged condition. It can however be ascertained that only the free water surface arising through filling of hold nr 2 would have raised the vessel's centre of gravity by approximately half a metre. If the timber had not entirely filled the hold but the logs, instead, had been able to move around or shift while floating, the vessel's metacentre height could have been decreased by half a metre through the effect of the free water surface alone. This could have constituted a serious risk to the vessel's stability.

2.6 Measures Taken Following the Accident

The Södertälje Traffic Information Centre was informed immediately, while the Marine Rescue Control Centre (MRCC) was not informed of the collision until the Maritime Inspectorate informed MRCC and the Coastguard Service approximately one and one half hours after the collision.

The investigation of damage to the Amur-2524 at the site of the collision was incomplete for several reasons. Shortly after the collision it should have been clear that the Tärnsjö had no significant damage and that she had not sprung a leak. Tärnsjö should then have had the possibility to assist the Amur-2524 by illuminating the damaged area and by breaking the ice so she could reach shallow water. Instead the Tärnsjö's master chose to leave the site right after the accident and before the Amur-2524 began her attempt to reach shallow water.

By then the Amur-2524's crew had only managed to begin investigating the damage. The investigation was incomplete and the officers' judgement of the extent of the damage and its consequences was thus partly incorrect. This resulted in their decision to proceed to Köping. After sailing for approximately four hours the officers realised there was a risk that they would not make it to Köping. The vessel

was instead escorted to Västerås. During the later part of the night the vessel sank further and so they had to arrange discharge of the cargo in Västerås.

It became apparent that they had misjudged what holds had become filled secondarily through various apertures and ruptured pipes. They had also misjudged the speed at which the water was entering.

It is often hard after an accident in which several holds are damaged to assess with any certainty the secondary effects such as gradual filling, flooding to other spaces and the creation of free water surfaces that can affect stability. In this case the situation was complicated by the fact that it was dark, that the vessel took on a pronounced list, that the holds were filled with timber and that there was cargo on the hatches.

Even with access to drawings aboard a ship, officers are usually not trained to interpret drawings, nor are they specially familiar with details of ship design. It is therefore difficult for them to evaluate how the damage can affect the safety of the vessel and crew.

Amur-2524 was told by the Maritime Inspectorate they could proceed. The Inspectorate probably lacked information as to the scope of damage and the vessel's design.

The board considers there was no reason for the Amur-2524 to continue her journey in the dark instead of waiting at the site for help with breaking ice to reach shallow water.

The Tärnsjö or the tug could have escorted the Amur-2524 back to Hjulsta bridge where they could have obtained help to pump out the bilge and investigate the damage.

Even if the vessel had been assisted by the tug during the journey, the Board estimates it would have been more difficult and risky to transfer the crew to the tug if the vessel had started to list or even capsized.

The Board considers it remarkable that the Tärnsjö's master chose to proceed immediately following the accident without ensuring that the Amur-2524 was out of danger. Evidently the vessel left the site without having fully ascertained the extent of the damage.

He was aware that the Amur-2524 was going to try to reach shallow water, but did not wait to see that she accomplished this.

Both the Amur-2524's master and the Tärnsjö's chief officer reacted when the Tärnsjö left the site. The chief officer, who was on the Tärnsjö's foredeck, said to the effect that: ”Can we leave them like this?” and the master said something like: ”There's nothing more we can do here.”

3 CONCLUSIONS

The immediate cause of the collision was that the meeting was poorly planned. Other contributing factors were insufficient communication between the pilots, and that the resources available on the bridge were not used in an effective manner.

4 RECOMMENDATIONS

None.