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Australian Transport Safety Bureau

AUSTRALIAN TRANSPORT SAFETY BUREAU

MARINE SAFETY INVESTIGATION
REPORT 178

Independent investigation into the contact with the number two coal loader at Port Kembla, NSW, by the Bahamas flag bulk carrier

SA Fortius

on 15 April 2002

COMMONWEALTH DEPARTMENT OF TRANSPORT AND REGIONAL SERVICES

Department of Transport and Regional Services
Australian Transport Safety Bureau

Navigation Act 1912
Navigation (Marine Casualty) Regulations
investigation into the contact with the number two coal loader at Port Kembla, NSW, by the Bahamas flag bulk carrier *SA Fortius* on 15 April 2002

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Summary

At 1148 on 15 April 2002, the Bahamas flag bulk carrier *SA Fortius* arrived off the New South Wales port of Port Kembla. The ship's deadweight was 88 674 tonnes at a mean draught of 10.655 m and it was trimmed almost 3 metres by the stern.

At 1300 the pilot embarked and the ship proceeded inwards to the number two coal loader, in the inner basin. The intention was for *SA Fortius* to enter the outer harbour, pass through the 'Cut' and turn to starboard through some 230° to berth, on a southerly heading, at the coal loader in the eastern basin. The wind speed was about ten knots from the south-south-east.

Approaching the breakwater, four tugs were made fast, one on a tow line through the forward centre Panama lead, two tugs alongside on the starboard side (one forward, the other aft) and a tug aft, on a line led through a stern Panama lead, on the port side.

The passage to the inner harbour apparently proceeded without incident. Once in the inner harbour the pilot initiated the turn to starboard utilising the ship's engine, rudder and the two forward tugs. The tug made fast through the forward Panama lead towed the bow to starboard, while the forward tug on the starboard side was used to slow the ship by coming astern.

After the ship had turned through some 90° it became apparent to the pilot that *SA Fortius* was experiencing a significant drift angle[1]. The master of the stern tug became concerned as *SA Fortius*'s stern was closing on the multi-purpose berth and the dolphin at the southern end of the grain berth. He anticipated that the next order from the pilot would be for his tug to take the stern to port and he positioned the tug forward of the beam, between the ship and the dolphin. The ship maintained headway, contacting the third fender from the southern end of number two coal berth on a heading of about 078° (T).

At, or immediately after, the time of contact the pilot ordered the two stern tugs to take the ship's stern to starboard. The stern tug however, had become temporarily trapped between the grain berth dolphin and the ship and sustained damage to its fenders forward and aft. At this time the tug positioned on the starboard side aft parted its tow line. The ship maintained a reduced rate of turn and cleared both the grain berth dolphin and number two coal berth, which had sustained damage in the initial contact.

SA Fortius was directed to berth at number one coal berth, where it completed mooring at 1523.

This report concludes that:

1. *SA Fortius* was too far north in the turning basin.
2. The engine was put to 'slow ahead' at about 1356, when the intended order was 'slow astern', the pilot appearing not to take notice of the tachometer and rudder angle indicator.
3. There was negligible bridge teamwork, resulting in a breakdown of communications between the pilot and the ship's staff on the bridge.
4. The master was not aware of the intended manoeuvre in the inner basin.

The report recommends that:

- Pilots use standard orders to tugs.
- Port authorities consider the use of electronic aids to assist pilots with berthing operations and the publishing of their pilotage passage plans on the Internet.
- Meetings be reintroduced between pilots and tug masters.

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[1] With the bridge aft, drift angle is the angle between the ship's heading and the direction in which the ship's bridge is travelling. Rowe, R.W. (1996) The Shiphandler's Guide, Nautical Institute.

Sources of information

Officers and crew of *SA Fortius*

The pilot

The tug masters of *Kembla II*, *Korimul*, *Bullara* and *Karoo*

Adsteam Towage Pty Limited, trading as Adsteam Harbour Port Kembla

The harbour master, Port Kembla

The Australian Maritime College, Ship Simulation Unit

Forensic Services Division, Australian Federal Police

Acknowledgment

Narrative

SA Fortius

The Bahamas flag vessel *SA Fortius* is a 'capesize[2]' bulk carrier owned by Braverus Maritime Inc of the Marshall Islands, operated by the South African Marine Corporation and managed by Enterprises Shipping and Trading SA of Athens, Greece. Built in Korea, the ship was delivered to the owners on 19 June 2001.

SA Fortius has an overall length of 289.08 m, a beam of 45.00 m and a moulded depth of 24.10 m. It has nine cargo holds and a summer deadweight capacity of 171 509 tonnes at a draught of 17.721 m. The ship is powered by a Hyundai-B&W 6S70MC engine which has a maximum continuous rating of 17 098 kW. The main engine drives a right-hand turning propeller to provide the ship with a service speed of 14.5 knots. During normal manoeuvring operations the main engine is controlled directly from the bridge.

The bridge, engine room and accommodation are aft of frame 47. The distance from the forward end of the bridge to the stem at frame 334 is 246.38 m. The ship has a bulbous bow which extends forward from frame 329 to frame 334. The distance from the bridgefront to the stern is 42.7 m.

At the time of the incident, the ship was under the command of a Polish master and had a crew of 20 Ukrainian nationals. In addition to the master, the complement consisted of three deck officers (mates), five engineer officers and 12 ratings. All the officers carried appropriate qualifications. The officers maintained a 'four-hours-on, eight-hours-off' system of watches at sea. While in port the two junior mates worked six hours-on, six hours-off, with the mate supervising the cargo operations.

Port Kembla

Port Kembla is a major bulk cargo handling port. In the financial year 2000/2001, some 15 million tonnes of cargo were exported from the port, principally 9.6 million tonnes of coal, with 7.6 million tonnes of iron ore imported into the port. During the same year some 659 vessels berthed at Port Kembla. The maximum length of vessel normally entering the port is 295 m, although, with permission from the harbour master, vessels up to 315 m have berthed within the port.

Port Kembla consists of an outer harbour connected to the main, inner harbour, by a channel known as the 'Cut'. The nominated, maintained depth of the inner harbour is 15.25 m, based on a datum of lowest astronomical tide (LAT), although it is shallower in the southern part and the periphery of the basin. The maximum tidal range is 2.10 m.

Ships approach the outer harbour on a heading of about 213°(T). Ships bound for the inner harbour start to turn through about 90° as the ship passes through the breakwater heads and then transit the 'Cut' on a heading of about 300°(T) to the inner harbour.

The inner harbour consists of the main basin, with Broken Hill Proprietary Ltd (BHP) berths on the southern and western side and the coal berths on the eastern side. The inner harbour turning basin is approximately 500 m in diameter. At the northern end of the inner harbour are two basins, the western basin and the eastern basin. The coal berths and the ro-ro and grain berths are located in the eastern basin.

Number two coal berth, about 270 m in length, is the main coal export berth and has a depth alongside of 16.25 m. The berth is fitted with eight fender units, spaced about 35.5 m apart, designed to absorb the shock of a ship coming alongside bodily. It can accommodate ships up to 315 m in length.

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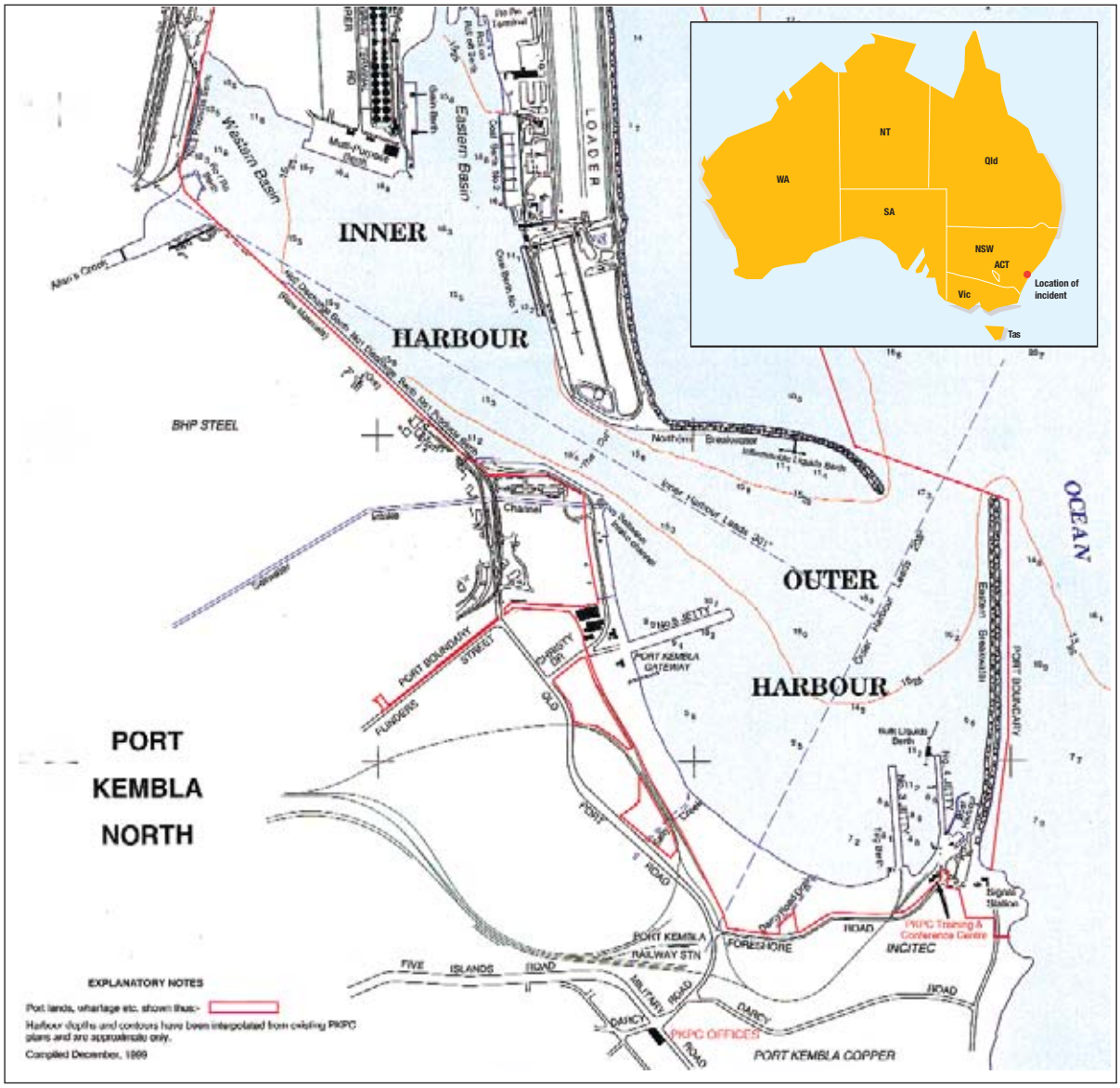
[2] Capesize bulk carriers are vessels that are too large (usually in terms of beam) to transit the Panama Canal, about 80 000 tonnes deadweight or larger.

FIGURE 2:
Port Kembla harbour



From 1 January 1996 to the time of the incident on 15 April 2002, some 942 bulk carriers have berthed at number two coal berth. Of this total, 265 ships were capesize vessels, mostly in ballast. Some part-loaded coal ships, however, have berthed in Port Kembla to load coal from the Illawara mines.

The port categorises capesize bulk carriers as:

- light displacement draught (approximate draught of 5.8 m for'd and 8.5 m aft for ships of 285 m length overall);
- 'medium ballast/part loaded' for vessels in excess of 9 m draught; and
- 'heavy ballast/part loaded' for vessels with a draught in excess of 10 m.

Fully loaded ships, normally iron ore carriers, berth 'head-in' on the southern side of the harbour at the BHP discharge berths. Ships in ballast, (coal ships, grain ships or steel product carriers) are swung in the inner harbour and berthed with their bows to the south. Ships are turned to starboard. While this means turning ships through 240° rather than 120°, the manoeuvring characteristics of most vessels, such as transverse thrust, make a turn to starboard the preferred option and the standard manoeuvre for the port.

The entrance to the outer harbour and the turn into the 'Cut' is considered to be the manoeuvre with the greatest risk. Port Kembla Port Authority has modelled all the above surface

features for the port and the underwater topography for the entrance and the 'Cut' on the ship simulator at the Australian Maritime College in Launceston. Also, part of the inner harbour had been modelled in April 2001 for projected developments in the north-west of the harbour.

Pilots employed by the Port Kembla Port Authority undertake a training and development program. The program is designed to progress each pilot through a series of competency steps from grade one at joining, to grade four (unlimited) pilot. The program allows for pilots to become familiar with the port and gain experience in handling ships of progressively greater length. Each progression includes training on the ship simulator at the Australian Maritime College. The port procedures provide for each pilot, regardless of grade, to be assessed annually by a senior 'check' pilot or the harbour master.

The pilot

The duty pilot on 15 April was engaged by the Port Kembla Port Authority in November 1995. He had had extensive previous experience handling bulk carriers, both at sea and as a pilot and assistant harbour master elsewhere in Australia. He had satisfied the port authority requirements for a grade four pilot in July 1997 and had attended a number of developmental courses including Bridge Resource Management and the Advanced Marine Pilots Training Course.

After attending the Advanced Marine Pilots Training Course, the pilot developed his own passage plan for the various berths within the port, based on diagrammatic representations of the various manoeuvres.

The harbour master had undertaken the pilot's current annual assessment, which the pilot completed successfully, in July 2001.

The incident

At about 1040 on 14 April 2002, *SA Fortius* berthed in Newcastle to load a part cargo of coal. Cargo totalling 55 140 tonnes was taken in holds one, four, six and nine. Loading was completed at 0311 on 15 April and the ship sailed at 0408 for Port Kembla.

SA Fortius completed its sea passage from Newcastle to Port Kembla at 1148 on 15 April. The ship's arrival draught was 9.24 m forward and 12.07 m aft with a deadweight of 88 576 tonnes. In addition to the 55 140 tonnes of coal, the ship carried 30 073 tonnes of ballast in both wing and double bottom tanks and fuel, fresh water and stores amounting to about 3460 tonnes. The ship's displacement was about 111 260 tonnes. The height of eye on the bridge was approximately 27.5 m,

At 1300 the Port Kembla pilot boarded the ship in position 34° 24.14' S, 150° 57.67' E, about 4.5 miles north of the eastern breakwater. The ship was to berth port side to number two coal loader in the inner basin on a heading of 178° (T).

At this time, the wind was from the south-south-east at about 10 knots. The tide was ebbing after high water at 0949 with a predicted height above datum of 1.3 m, and low water was at 1539 with a predicted height of 0.4 m. The height of tide at the anticipated time of berthing at 1400 was 0.6 m, giving *SA Fortius* a minimum under-keel clearance (UKC) of 3.53 m.

Approaching the breakwater on a heading of about 213°(T)[3], four tugs attended *SA Fortius*. By 1331, the tug *Korimul* was secured by a line through the after Panama lead on the port side aft and the tug *Kembla II* was secured on a line through the Panama lead at the bow. By 1335 two other tugs were made fast on the starboard side of the ship, the tug *Bullara* forward in way of number three hold and *Karoo* aft in way of

[3] All ship's headings given have been taken from the ship's course recorder, which was reading about 1° low.

number nine hold. *Kembla II* is a twin screw, steerable 'Kort Nozzle' tug and had its tow line rigged over its stern. *Korimul*, *Karoo* and *Bullara*, are stern drive, 'Z-peller', tugs and were using their forward tow lines passed over their bows.

At 1335, the ship was logged by harbour control as entering the port. The main engine was set to 'dead slow ahead' at 35 rpm, giving a nominal speed, according to the pilot card, of about 6.5 knots. *SA Fortius*, under the pilot's direction and assisted by the stern tug, turned through 90° to a heading of about 306° to pass through the 'Cut' into the inner harbour. To assist the turn, full starboard rudder was applied and the engine revolutions were increased to 'slow ahead', 40 rpm, for seven minutes.

At about 1342 the ship steadied on a heading of about 305°, with the 'Cut' leading marks just open to the south. At 1343 the engine speed was reduced to 'dead slow ahead'. The turn, through about 90°, had reduced the ship's speed. The pilot recalled the GPS indicating the speed as being 3.2 knots, as it entered the inner harbour.

The pilot stated that with capesize vessels in ballast, he and other pilots tended to 'drive them round' with minimum tug usage. However, as a partially loaded vessel of some 110 000 tonnes displacement, he intended to stop and take the way off the ship about half way through the turn and use the tugs to a greater extent to turn the ship to berth port-side-to.

The general consensus of the witnesses is that the passage proceeded routinely to the inner harbour. None of the tug skippers regarded the speed through the 'Cut' as out of the ordinary; one thought that, if anything, the ship was moving slower than usual and may have been a little to the north of the 300° leading lights.

As the bridge of *SA Fortius* entered the inner harbour the pilot ordered the helmsman to steer 310°(T). The pilot prepared to turn the ship to starboard through a total of 235°. When he could see the roll-on/roll-off berth clear of number two coal berth, he ordered '20° of starboard rudder' and, almost immediately, 'full starboard rudder'.

The master stated that, at this time, he accompanied the pilot as he moved from the wheelhouse to the port bridge wing. The master also stated that both of them remained on the port bridge wing throughout, until the vessel was actually berthing after the incident.

At about 1348, with full starboard rudder and the engine speed increased to 'slow ahead', the ship started its turn. After two minutes, at 1350, the engine speed was reduced to 'dead slow ahead' and *Kembla II* was ordered 'stand by, bow to starboard'. At about 1351, the pilot ordered *Bullara* to 'lay back and come astern'. Forty four seconds later the pilot ordered '*Kembla II*, bow to starboard'.

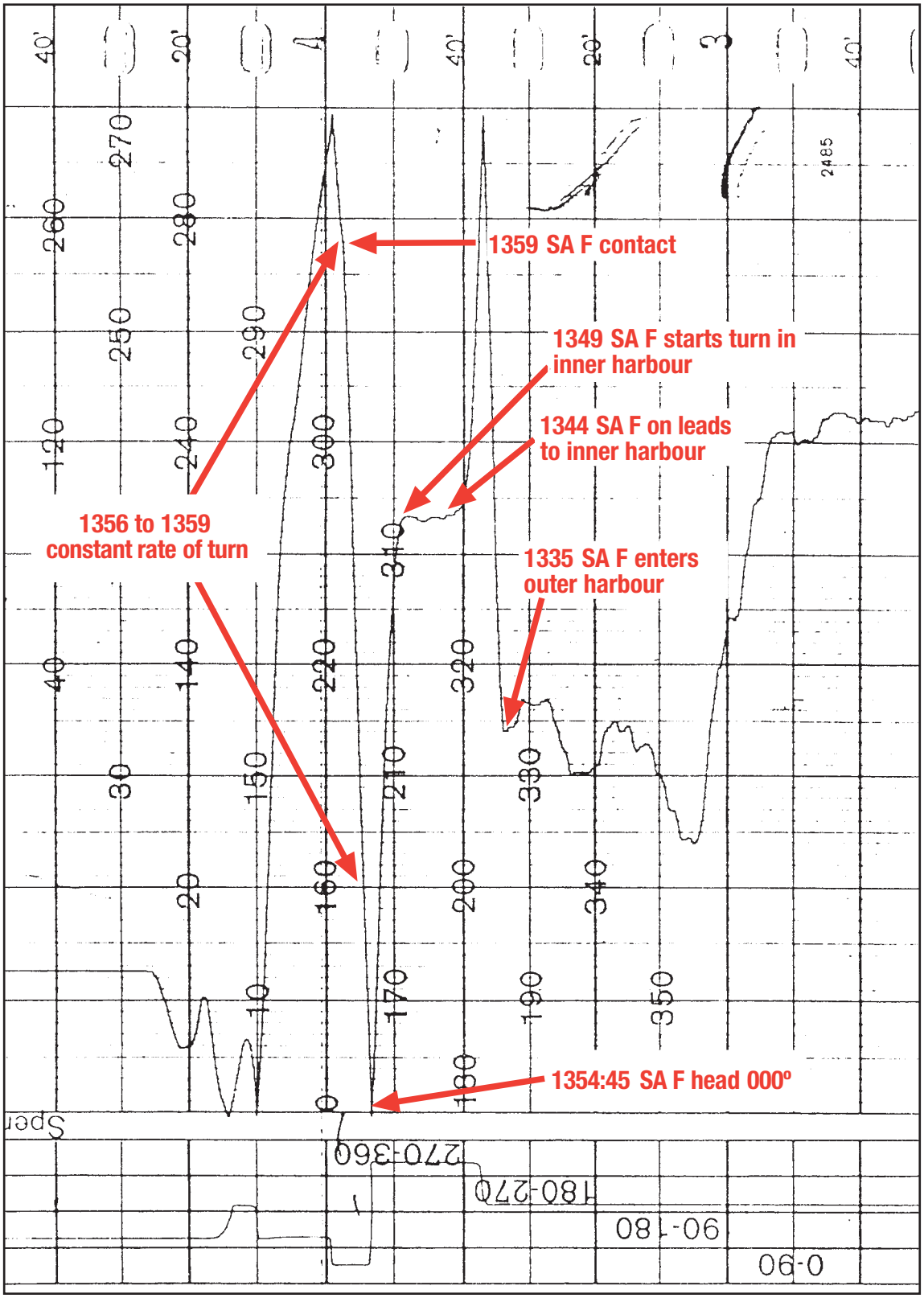
With the first part of the turn established at a rate of about 14°/min, *SA Fortius* was turning at an apparently satisfactory rate to starboard. After the ship's head passed through 000°(T), the rate of turn had increased to an average of 19°/min. The pilot estimated, by the relative position of the bridge within the inner basin, that the bow was about 100 m from the dolphin at the southern end of the grain berth. A marine professional watching from the shore thought that, initially, the manoeuvre was following the normal routine.

At this stage, *Bullara* was maintaining a braking force alongside and *Kembla II* was towing the bow to starboard. At 1355:45 the pilot ordered *Bullara* to stop. The main engine was still at 'dead slow ahead' and *Kembla II* was maintaining its pull to starboard. At about 1356 the master and mate recalled that the pilot gave an engine order of 'slow'.

It was at about this time when the witness on the shore realised that the ship's drift angle was unusually large and the ship's stern was closing with the eastern end of the multi-purpose berth.

The pilot, however, recalled that he had initially ordered 'stop engine'. He said that he saw the mate put the telegraph to stop and watched the tachometer return to zero revolutions. He indicated that he had then moved from the port side of the wheelhouse to the outside of the port bridge wing, directly in front of a main engine

FIGURE 3:
Course recorder trace for entry to Port Kembla



Note: Recorder time 1½ minutes slow and 1° low.

tachometer and rudder angle indicator, from where he ordered 'slow astern'. Both the tachometer and rudder angle indicator are fixed at about waist height, on the bridge wing dodger. He recalled seeing the tachometer 'flicker' and assumed that the engine was going astern.

Neither the master nor the mate recalled that any order was given to stop the main engine or put the wheel amidships and that the order given by the pilot was for 'slow ahead' as recorded in the bridge 'bell book'. The examination of the 'bell book' would suggest that, although poorly maintained as a contemporaneous record (the overwriting and erasure calls into question its accuracy), no entry had been made for 'stop engine' prior to 1357.

The stern tug *Korimul* was standing-by off the port quarter in anticipation of an order to take the stern to port. In the tug skipper's judgement, the distance between the ship's port side aft and the dolphin at the south end of the grain berth was reducing. If he was to be able to position *Korimul* to take the stern to port when the stern cleared the multi-purpose berth, he had to position the tug forward of the beam. He moved the tug between *SA Fortius* and the dolphin so that *Korimul* was forward of the ship's beam with no slack in the towline.

From about 1356 the master was communicating by UHF radio with the second mate on the bow, who gave a continuous estimation of the distance of the bow from the berth. The master stated that he had relayed these distances to the pilot.

From 1357 to the contact, events occurred in rapid succession. At 1357:20, a minute and 35 seconds after ordering *Bullara* to stop, the pilot ordered *Bullara* to 'lay back, come astern'. The pilot was becoming concerned that the stern

FIGURE 4:
Damage to coal berth

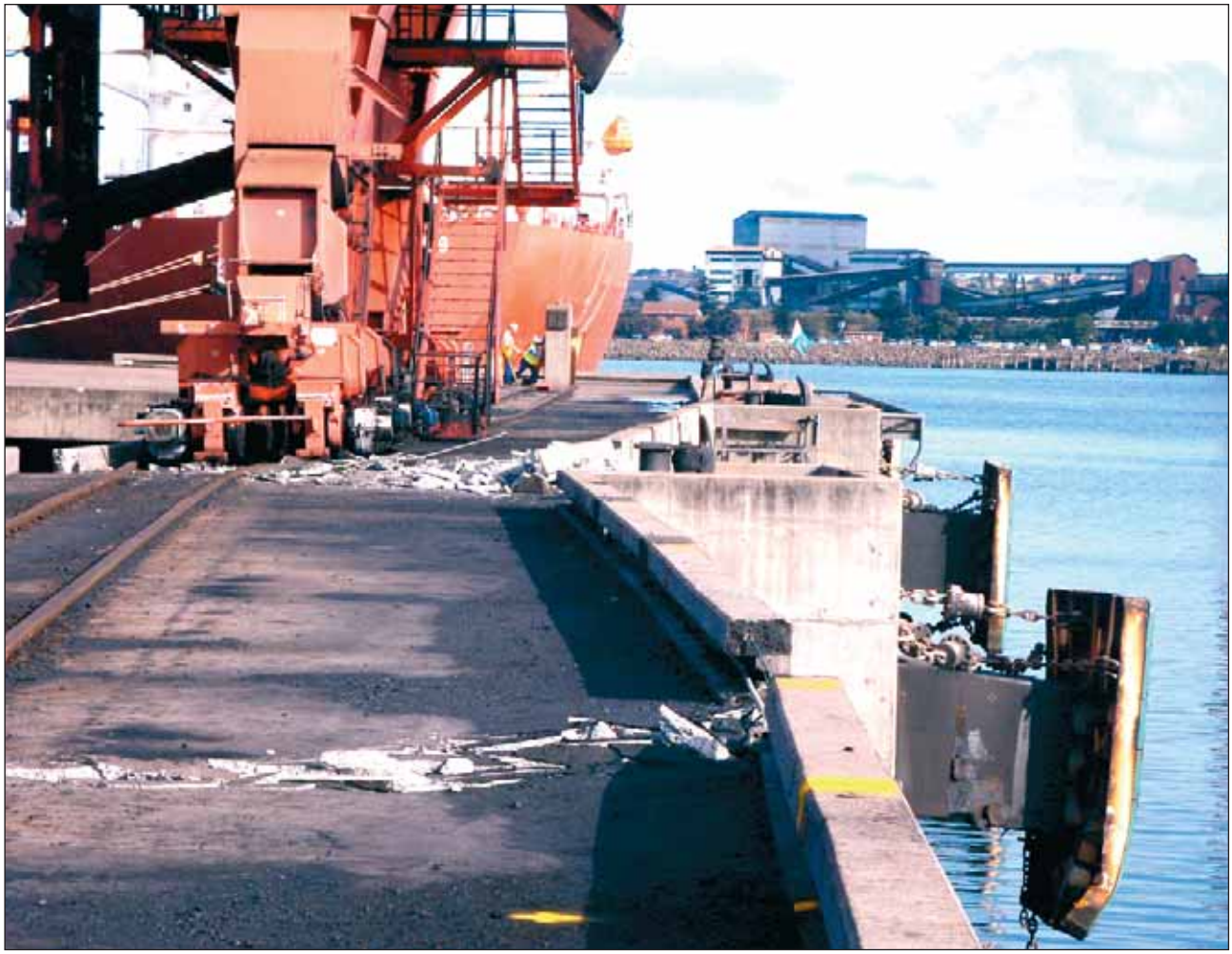
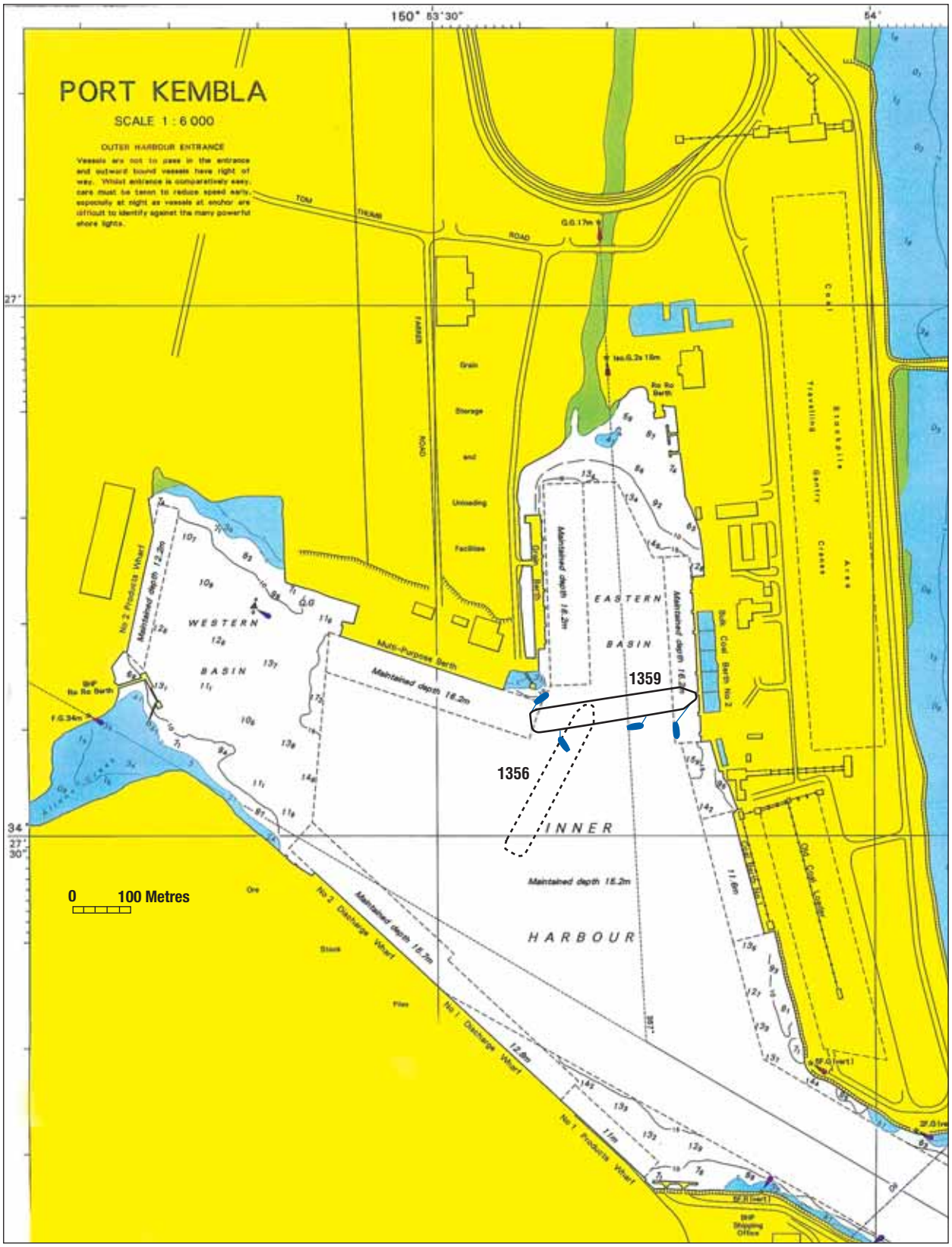


FIGURE 5:
Portion of chart Aus 195 showing ship contacting the wharf



was too close to the dolphin. He was not concerned that the bow would contact the coal berth as he was satisfied that *Bullara* was providing the necessary braking force to arrest the ship's forward motion. A few seconds later the master of *Kembla II* gave his first warning that the bow was unusually close to the wharf.

The pilot recalled that he had looked at the tachometer and rudder indicator as it seemed to him that the turn had stalled. He saw that the tachometer was showing ahead revolutions and he recalled that the rudder angle indicator showed full port rudder. He ordered 'stop engine' at a time entered in the bell book as 1357. The order to 'stop engine' was immediately followed by an order for 'dead slow astern' and for the rudder to be put amidships. The order for 'dead slow astern', recorded as 1358 in the bell book, was followed in quick succession by 'slow astern' and then 'full astern'.

The master, mate and helmsman, all deny that the rudder was put to port at any time. The master stated that it was only after he told the pilot that the speed was too high, that the pilot ordered 'stop engine'.

The master was becoming increasingly anxious that the ship was turning too quickly and he was concerned at the proximity of the berths both ahead and on the port quarter. He stated that he had ordered the engine movements astern, at about 1357.

At 1357:33, the master of *Kembla II* gave a second warning and the pilot responded almost immediately at 1357:46, ordering *Korimul* to take the 'stern to port'. *Korimul*'s master responded:

> 'Ain't got much room here,…, I'm nearly on the dolphin.'

Thirty one seconds later, the pilot repeated the order to *Korimul*, this time the pitch of his voice was raised and he was exhibiting signs of marked stress. *Korimul*'s master replied that he was '…trying cap'. *Karoo*, the after tug on the starboard side, then radioed that he was 'going to pull, stern to port'. However 20 seconds after the instruction to *Korimul* to pull the stern to port, the order was rescinded and *Korimul* was ordered to 'stop' and then 'push up, stern to starboard'. *Karoo*, in turn, was ordered to 'come astern full power'.

At about this time, the bow of *SA Fortius* made contact with a fender, 70 m from the southern end of number two coal berth. The ship was on a heading of approximately 078° (T) at the time of impact and almost at right angles to the wharf. At the same time, the flare of the ship's bow contacted the coal loader damaging it. The wharf was damaged by the impact and the loader was dislodged from its rails. The time of the contact logged by the ship was 1359. The pilot ordered *Kembla II*, still taking the bow to starboard, to stop.

At the same time, *Korimul* was having difficulty in getting square with the ship to push up, as the port side of the ship was about 30 m off the dolphin at the southern end of the grain berth. The ship started to come astern. Around this time the tug came into contact with the dolphin and a tubular steel rope guide at the southern end of the grain berth. This problem was compounded by the ship's stern way. *Karoo* was also having difficulty in squaring up to the ship as the ship gathered stern way.

A few seconds before 1400, *Karoo*'s tow line parted and the pilot ordered 'stop engine'. Using the engine and the tugs, the pilot manoeuvred clear of the dolphin and continued to turn the ship to starboard. At 1405, the ship's crew passed a mooring line to *Karoo* and the tug made it fast forward.

At 1410 the ship had reached a southerly heading. At about 1413 Kembla Port Control informed the pilot that the ship could not go alongside number two coal berth and was directed to number one coal berth. At 1430 *SA Fortius* arrived alongside number one coal berth.

Special mooring arrangements were required to secure *SA Fortius* at number one coal berth, requiring the placement of additional mooring lines. When the ship was alongside, the harbour

master boarded and discussed the situation with the pilot. Certain mooring ropes needed relocating. The pilot disembarked from *SA Fortius* at 1505 and the harbour master remained on board until the ship was finally secure alongside at 1523.

The incident had resulted in significant damage to number two coal berth. The fender struck by *SA Fortius* was badly deformed, as was the steel reinforcing strut from the fender to the shore. A section of the wharf's reinforced concrete decking had been broken away and set back and the walkway connecting the wharf to the shore was buckled. The coal loader had been derailed by the impact and had suffered some damage as a result.

Korimul sustained damage to its fenders and sponsons on the starboard side, both forward and aft. *Karoo*'s main towline had parted about a metre from the eye; the plasma tail had remained intact.

Comment and analysis

Evidence

SA Fortius was less than a year old and was fitted with full bridge control for the main engine. However, it was not equipped with an automatic engine movement recorder. All times of engine movements were entered manually in the bridge 'bell book' by the officer on the bridge. Times were entered to the nearest minute. No record was kept of passing the breakwater, or of the times of passing any of the navigational marks or other prominent features. There was no record of the ship's speed.

The problem with manually recording engine movements to the nearest minute is that the time between two consecutive records is accurate only to between one and two minutes. (A movement which is given at 25½ minutes may be recorded as being at either 25 minutes or 26 minutes and if the next movement is given at 27½ it may be recorded as 27 minutes or 28 minutes. Hence, the two minutes between movements may be recorded so as to appear to be as long as three minutes or as short as one minute.)

The ship's 'bell book' was a soft covered, purpose-formatted engine movement recording document. Between soft covers the book consisted of 100 pages. The 55th page was used for recording the ship's entry to Port Kembla, which followed sequentially from the berthing and sailing from Newcastle. Some of the pages had been completed in ink while others, including the arrival and berthing at Port Kembla, had been completed in pencil. The pages were not numbered and it is not unknown after accidents for pages to be removed and records to be rewritten. In view of the conflicting evidence relating to the engine movement at 1356, the ship's bell book was submitted to the Forensic Services Division of the Australian Federal Police. Forensic Services were asked to determine:

- whether any pages had been removed,
- the writing medium,
- if there had been any overwriting on 15 April, and
- whether there had been any erasures on 15 April.

The examination concluded that:

- there was no evidence that any pages had been removed,
- there were a number of writing mediums and, on at least 5 occasions, a pencil was used to record engine movements,
- two entries on 15 April had been overwritten in the 16th line, 'dead slow astern' at 1358 and 'slow astern' at 1358, – the original characters could not be determined, also,
- one entry had been erased in the 'full ahead column' of the 16th line, which read 1358.

The engine control room was equipped with an automatic alarm logger and its print-out was examined. None of the alarms recorded around the time of the incident provided the investigation with any assistance in reconciling times of main engine movements with those recorded in the bell book or with statements made by the various witnesses. No alarms were recorded before the contact with number two coal loader that were relevant to the operation of the main engine, the steering gear or other relevant machinery.

The course recorder was of a type that showed the ship's heading by quadrant. There was no trace to show the rudder angle. The course recorder was between one and two minutes slow of ship's time.

The ship's bridge clock was about 15 seconds faster than the ship's GPS receiver time. Based on the time that the line from the tug *Karoo* parted (just before 1359:56), it would seem that the time recorded for contact with the jetty by the ship's mate in the bell book, is accurate to about ±30 seconds.

The ship, being in its first year of operation, was under builder's guarantee. The list of 'guarantee claims' and the individual guarantee 'claim forms' were reviewed to establish whether the ship may have had any mechanical or equipment malfunction that may be relevant to the accident. None were found.

The only independent sources of time were those of the port control recordings of VHF radio traffic and the video from the port security surveillance cameras. The VHF channel 8 radio recordings provided an accurate record of the tug orders. Using Co-ordinated Universal Time (UTC) the recording time and the ship's GPS should have been the same. A security camera sited on the southern end of the grain terminal conveyor captured video of *SA Fortius* entering the outer breakwater, approaching the 'Cut' and the ship's final approach to the berth from 1355:09. The camera was situated 370 m from the point of contact at a height of 67 m above sea level (at 1400) and had a field of view of approximately 25°. The time on the security video appeared to be about one minute fast when compared with the voice tape.

In submission, the shipowners and the mate stated:

> The bell book is a contemporaneous record maintained in accordance with universally accepted practise. It was not altered after the event. Any changes made at the time by the Chief Officer emphasise the effort made to ensure it was an accurate record.
>
> The Chief Officer highlights this level of accuracy, also stressing that the times between consecutive records in the bell book are similarly accurate. The orders of, for example, 1357 'stop', 1357 'dead slow astern', 1358 'slow astern' and 1358 'full astern' demonstrate this and show that a suggestion of accuracy of up to 3 minutes cannot be correct.

However, in the Inspector's opinion, the normal convention is that bell books are used to record times to the nearest half-minute.

The time of contact

The precise time of contact is not known. The ship recorded the contact as 1359. This is consistent with information from a ship surveyor who was standing ashore adjacent to the number two coal loader. The surveillance security camera shows contact at almost exactly 1358. The course recorder, about a minute and a half slow, shows a marked deceleration in the ship's rate of turn, on a heading of 078°, at a time of 1357½.

Shortly after the bow of *SA Fortius* made contact with the fender on the coal loader jetty, the tug *Korimul* became temporarily trapped between the dolphin at the end of the grain berth and the port side of the ship. This occurred after the contact. The length of *Korimul* is 32.5 m. Therefore, at the time of contact, the ship's port side was a little over a tug's length off the dolphin (between 35 and 50 m). Making allowance for the distance to the ship's centre line, the probable heading at the time was about 078° (T). This also coincides with the deceleration in the rate of turn on the ship's course recorder a few seconds before 1359.

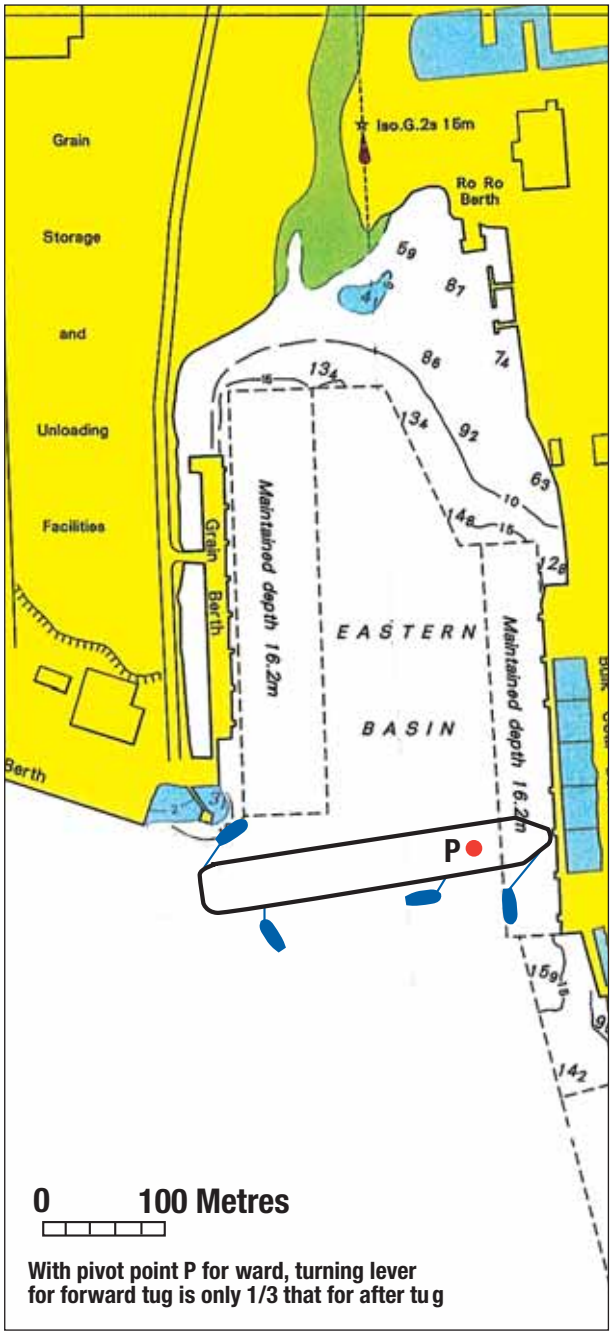
The time of contact has been taken as 1359 and the times from the security camera and the course recorder have been adjusted accordingly.

The turn

The pilot's plan was to enter the inner harbour and turn the ship to starboard. This manoeuvre is the standing operational procedure in the port for ships in ballast and part loaded berthing at the number two coal loader. The greater part of the turning moment would be generated from the ship's propeller, with full (35°) starboard rudder. Theoretically, a turning ship with forward way would pivot about a point forward of number three hold (25 per cent of the length from the stem). In terms of tug power, the after tugs could provide a far greater turning moment than tugs forward, a factor that a pilot must balance against other considerations in the manoeuvre.

The pilot intended to use the two forward tugs, *Kembla* in towing the ship's bow to starboard and *Bullara* to create a braking effect, to arrest any excessive forward motion imparted by the

FIGURE 6:
SA Fortius **showing pivot point P and position of tugs**



With pivot point P for ward, turning lever for forward tug is only 1/3 that for after tug

main engine ahead revolutions. Once the ship's stern was clear of the general-purpose berth, the two after tugs would assist in manoeuvring the stern to port and complete the berthing operation.

A period of about nine minutes elapsed between the time that the ship's head started to turn to starboard, after entering the inner harbour and the contact with number two coal berth.

SA Fortius, being a large full-bodied ship is prone to large drift angles and lateral motion. At some time during the turn a significant drift angle developed which resulted in an enlarged radius of turn. Over the first 2½ minutes *SA Fortius* turned at a rate of 7°/min followed by a rate of about 14°/min over the next 2½ minutes. From a northerly heading at about 1354:45 to the time of contact at 1359 the rate of turn averaged about 19°/min. The course recorder trace shows no change in this latter rate of turn in the three minutes before contact.

With the wind from the south-south-east (about 160°) at 5 m/sec, maximum wind effect would have occurred as the wind came onto the beam. However, based on an estimated windage area of 4 300 m^2, the wind would have exerted a force of about six tonnes[4]. The effect of the wind on *SA Fortius* would have been minimal.

When the engine revolutions were increased to 'slow ahead' at the beginning of the turn (1348 to 1350) with full starboard rudder, the effect would have been to increase the rate of turn without unduly increasing the ship's forward way through the water. Given the manual recording of movements to the nearest minute, it is not possible to establish whether the engine was at slow ahead for one or three minutes, or for some period in between.

The critical period of the turn seems to have been at about 1356. This was the time at which the pilot said that he had ordered 'stop engine' and saw the tachometer return to zero, an observation disputed by the ship's staff on the bridge and not supported by the movement orders recorded in the bell book. The bell book in fact records an engine movement of 'slow ahead'.

The owners and master submitted:

> This may have been a critical time but the critical time was the position, heading and momentum of the vessel prior to the start of the turn. The vessel required a heading of 307° to transit the cut, she crossed the leading line of 300°(T) without being brought back onto it, placing her too far North

[4] Wind force (tonnes) per 1000 m^2 = V^2/18 (where V is the wind speed in m/sec)

> before the next turn was contemplated and with too much momentum. It is denied by the Master that the pilot ordered 'stop engine' at this time. The engine was ordered stopped at 1357 upon the suggestion of the Master.

In submission the pilot stated:

> At the time (around 1355 hours) I gave the first slow astern instruction, the vessel was around 200 metres off the No.2 bulk coal berth on a heading of around 030 degrees. With the vessel in that position, I suggest that it is inherently unlikely that any experienced pilot would have given any form of order for an ahead movement. There was simply insufficient space to effect any manoeuvre ahead. It was for this reason that I gave the stop engines and slow astern orders at this time.
>
> In my submission, you would be entitled to take into account the inherent unlikelihood that I would have maintained an ahead engine setting in the vessel's situation at the time, and accordingly prefer my version of events, specifically that I gave a 'slow astern' order at around 1355, which was not complied with.

The Inspector accepts that the logical order would be to put the engine astern and either take all way off and shift the pivot point amidships, or to induce some stern way and move the pivot point aft to allow the forward tugs a greater lever. This would seem to be the most straightforward manoeuvre and consistent with the pilot's stated plan. However, it is not unknown for pilots to give an order in error, for ship's staff to misunderstand the order, or for the ship's staff to execute an incorrect order. In the absence of an independent recording medium it is not possible to determine what orders were, in fact, given.

At 1356:25 the bow of *SA Fortius* came into view of the security camera mounted on the grain terminal. According to the pilot, it was around this time that he thought the swing had stalled. He saw that full port rudder had been applied and the engine was at 'slow ahead' rather than 'slow astern'. The ship's heading at this time was about 030°.

By triangulation, based on the known height of the camera and the height of the ship's main mast and samson posts, it is possible to calculate the distance of the ship's bow from the camera. The course recorder provides the ship's heading 2½ minutes before contact.

On this basis, at 1356:25, *SA Fortius*'s bow was 110m from the dolphin at the southern end of the grain berth (± 20 m) and 180 m from number two coal berth, heading about 030°.

Whatever order was given by the pilot at 1356, the engine was put to 'slow ahead'. The main engine had been on constant ahead revolutions for a period of six minutes and the ship had turned through a heading of between 75° and 90°. With the main engine on 'slow ahead' and no braking effect from the tug, the ship would have accelerated while turning which would have helped to overcome the lateral resistance and induced sideways motion.

It is also probable that the pilot was not able to accurately judge the speed of the ship through the water and that the forward way was greater than he estimated. This could have led to *SA Fortius* being further north in the turning basin than was desirable. If the pilot had realised sooner that *SA Fortius* was too close to the multi-purpose berth and the dolphin, his position would have been assisted by utilising the after tugs and using *Bullara* on full power (it is noted that the pilot thought that *Bullara* was using full power when following his orders). Neither of the two after tugs was utilised in the inner harbour until about one minute before contact when he ordered the stern tug to take the 'stern to port'. However the ship was not clear of the dolphin and the tug was unable to comply.

The owner and master submitted:

> The GPS is located in the chart room immediately behind the wheelhouse. However a Doppler log is situated in the wheelhouse. It is considered that speed through the 'cut' is a critical issue. The tide, at the time, was ebbing which would have created a funnel effect of

> water through the cut from the inner harbour. This would have caused the vessel's speed over the ground (but not through the water) to decrease (note that the Doppler log would calculate speed over ground). Once clear of the cut the speed over the ground would increase (all other things being equal) to the amount of flow of water through the cut. With respect to the vessel's forward momentum (mass x velocity squared), an increase from 4 knots to 4.5 knots would result in a 25 per cent increase in momentum. An increase from 4.0 knots to 5.0 knots would result in about 50 per cent increase in momentum.

This is supported by the concern that the master of the stern tug *Korimul* had at the diminishing space, in which to manoeuvre his tug, between the ship's port quarter and the eastern end of the multi-purpose berth. He anticipated that, once the ship's stern had turned clear of the end of the multi-purpose berth, the pilot would instruct him to take the stern to port and start to back the ship into the eastern basin. He estimated that if he stayed at an angle of 45° abaft the port quarter he would not have room to manoeuvre as required by the pilot. *Korimul*'s master manoeuvred his tug forward of the beam. In so doing there would have been some weight on the towline as the tug rotated its position about 45° forward of the beam.

In submission Adsteam Towage Pty Ltd stated:

> The weight on the line however was the minimum weight which would allow *Korimul* to manoeuvre effectively. The master of *Korimul* was mindful of maintaining the bare minimum weight on the line in order not to impart any turning movement on *SA Fortius*. The amount of weight on the line was therefore negligible.

At 1358:03 the pilot gave the anticipated order '*Korimul*, stern to port'. The reply from *Korimul*'s master 'Ain't got much room here…' referred both to the fact that the tug was very close to the dolphin south of the grain berth, and also that the ship's stern would not clear the dolphin.

The manoeuvring of *Korimul* would have exerted some moment on the stern of *SA Fortius*, initially to port and, once forward of the beam, to port and ahead. The amount of forward moment imparted is hard to judge as the tug's manoeuvre was initiated because the ship's stern was unusually close to the multi-purpose berth. However, by far the most significant forward momentum came from the ship's ahead engine movement.

In submission Adsteam Towage Pty Ltd stated:

> One must be mindful that *SA Fortius* at the time of the incident had a displacement of 111 260 tonnes. Once this fact is considered, even if it is found that there was weight on the line it could only have been in the order of 10 tonnes, which in our view would not have had any effect on the vessel. Assuming that *Korimul* was 45° forward of the beam and using simplistic mechanics theory, it could be said that, of the negligible moment imparted by *Korimul* on *SA Fortius*, approximately 70 per cent would have been to port and approximately 70 per cent of that negligible moment would have been forward. As mentioned, the weight on the line was a bare minimum and 70 per cent of that would have been exerted forward. Your contention that the amount of forward moment would be hard to judge could be more accurately categorised as 'the amount of forward moment imparted by *Korimul* on *SA Fortius* was negligible. You state that by far the most significant momentum came from the ship's ahead engine movement and we agree insofar that the most significant and only material forward momentum emanated from the ship's ahead engine movement.

The bridge 'team'

A pilot has a detailed knowledge of the port and assesses the relative position of a ship's bridge, stern and bow from transit marks. But ships vary in their handling characteristics, depending, for instance, on size, hull form, power, rudder size, propeller pitch and draught. The master should have detailed knowledge of the ship's characteristics.

SA Fortius's pilot card shows that the propeller speed at dead slow ahead is 35 rpm, which gives a speed of about 6.5 knots. This speed

would seem to be at the upper end of the normal 'dead slow ahead' range for large bulk carriers.

The passage from sea to the inner harbour appears to have been routine and unremarkable. The pilot, who was standing at or near the centre of the wheelhouse, initiated the turn to starboard when the bridge was in line with the roll-on/roll-off berth in the eastern basin. The initial stages of the turn seemed to the tug skippers, the pilot and the witness ashore, to proceed normally.

Although the pilot has the conduct of the vessel, the master remains in command and must act in the best interest of the ship. The master has the obligation to relieve and overrule the pilot if the master considers the ship is being placed in danger. This principle, however, is complicated by the nature of ship handling, particularly large bulk carriers.

> A ship represents a type of reacting system which is especially 'slow', ie. feed-back is not available in direct and immediate form due to both the enormous inertia of the vessel and the fluid nature of its physical environment.

And…

> The task is very different on the ship bridge not only because actions taken now affect the vessel at some time in the future, and cannot be readily undone, but also because clues from the environment are often sparse. The type of complex mental modelling which is implicit in the ship bridge control task remains, however, imperfectly understood.[5]

It is always very difficult for a master, who is not thoroughly familiar with a port, to estimate the normal clearance distances and the relative position of the bridge within a turning basin, to take the conduct of the ship from a pilot. In this case, the communication between the master, mate and pilot fell far short of a desirable standard.

The owners and master submitted:

> The Master did not receive any written information or the pilot's personalised passage plan. The ship's pilot card and ship's particulars were provided to pilot. Additionally, the full details of the vessel's manoeuvring characteristics are set out in detail on two prominent fixed signs located both in the chart room and the wheelhouse. The pilot was provided with the laden details of the vessel. The Captain was only given oral information regarding the tugs and berthing, etc when he asked the pilot. The pilot did not volunteer any information and the Captain had to request information several times.
>
> The Master was not advised of the communications with the tugs. All orders received from the pilot by the Master were communicated to the mate on the bridge. The Master states that there was no communication or language difficulties with the pilot. In addition all deck and engine officers were able to hear the Master's commands via VHF radio. Generally regarding communication, the Master emphasises that all orders received from the pilot were immediately relayed by the Master to the Chief Mate in the wheelhouse. The Master, Chief Mate and the Mates on the bow and stem together with the Chief Engineer and engine room staff would hear the Master's orders from the radios with which they were all equipped. The Master further emphasises that there were no language problems and that he kept the pilot fully informed regarding orders being carried out because all his orders to the mate were acted upon and acknowledged. The Master repeatedly asked the pilot for information and intended manoeuvres, making his own disquiet known to the pilot.

Conflicts in evidence

Master/pilot exchange

There were significant conflicts in the evidence gathered at interview, between the pilot's account of the passage from the boarding ground to the contact with number two coal loader and the accounts given by the ship's staff.

The second mate stated that the ship had prepared a pilot boarding card, which was produced in evidence. The mate stated that he

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5 Bryant, D., De Bievre, et al, The Human Element in Shipping Casualties Phase II, Tavistock Institute, London.

showed the card to the pilot. The pilot's name was filled in on the boarding card, but the pilot had not signed it. The mate suggested that it was not the practice for pilots to sign the cards. The pilot stated that he was not shown this document, but there was a card with ship's particulars, which he looked at under his own volition.

The pilot stated that, after boarding, the second mate played no part in any conversation or information interchange. The pilot stated that he showed the master his personalised passage plan for entry to Port Kembla and the berthing manoeuvre for ships in ballast/part loaded bound for number two coal loader. He stated that he explained to the master with the aid of diagrams, that the ship would swing to starboard in the inner harbour. The master denied this and stated that he had, in fact, asked on two occasions, both on the approach to the breakwater and when passing through the breakwater, just what manoeuvre the pilot intended.

The pilot also stated that he had reviewed data on *SA Fortius* on the Port Corporation's computer system before boarding. He stated that he had obtained the ship's speed settings from a notice posted near the telegraph. The pilot submitted that he was not presented with any information by the master, except for the loaded condition, in response to his query. The pilot went on to state that it is his practice to sign a pilot boarding card when he is presented with one.

There is no independent evidence to corroborate either the pilot's or master's statement.

Approaching the berth

The pilot and the ship's staff on the bridge provided significantly different accounts of the events from about 1348, when the ship started its turn in the inner harbour, to the time of contact.

The pilot maintained that the master remained in the wheelhouse at all times and he had to shout his orders to the master. The master, mate and helmsman all state that the master followed the pilot to the bridge wing and that all orders were passed by UHF radio channel 11. These UHF orders were also relayed to the mates at the forward and after mooring stations and the chief engineer in the engine room, all of whom carried UHF radios.

The pilot stated that, at some time after he ordered the tug *Bullara* to stop at 1355:45, he saw that the swing to starboard had stalled. This he initially attributed to the erroneous application of full port rudder by the helmsman. The helmsman and the mate both deny that the rudder was put to port at any time after entering the inner harbour and before the contact.

The course recorder trace from 1356 until 1359 shows a constant rate of turn of almost 20°/min, with no reduction in the rate of turn until the ship reached a heading of 078°. At about 1359 the rate slowed to about 5°/min for some 30 to 45 seconds, before increasing to about 10°/min. The constant rate of turn shown on the course recorder trace is not consistent with the rudder having been put to port.

The pilot had the means of checking any rudder or engine order given, the ongoing rudder position and the engine revolutions, from the rudder angle indicator and the tachometer. He was in the wheelhouse for much of the time and stated that he saw the tachometer return to zero revolutions at some time after 1354. The tachometer and rudder angle indicator are next to each other above the central windows of the wheelhouse, and on the bridge wings. It is therefore improbable that, if the rudder was to port, it was while he was in the wheelhouse.

The owners and the master submitted:

> The Master states that the pilot moved from the wheelhouse to the port bridge wing when the turn was started on a heading of 310. The pilot was accompanied by the Master, both of them remaining on the port bridge wing throughout, until the vessel was actually berthing after the incident.

FIGURE 7:
SA Fortius wheelhouse

FIGURE 8:
SA Fortius looking forward from port bridge wing

However, the harbour master, who was at the grain berth, noticed that *SA Fortius* seemed closer to the general purpose berth than was normal. He went to the adjacent multi-purpose berth at about the time that contact was made with number two coal loader. From the dock side he could see the pilot, but stated that he could not see the master.

If port rudder had been applied after the pilot left the wheelhouse, and he did not notice the indicator on the bridge wing, then the port wheel would probably have made little, if any, difference to the rate of turn. The pilot provided a statement that it was his experience and that of other pilots in Port Kembla, that once a rate of turn to starboard had been established on low ahead engine revolutions, applying full port rudder had no effect for at least 30 seconds.

The pilot also stated that, while inside the bridge on the port side, he gave the order 'stop engine'. He recalled that the master acknowledged the order and that he saw the mate move the telegraph to the stop position. He also recalled seeing the main engine tachometer move to zero. There was, however, no record of any such engine order made in the bell book.

In submission the pilot stated:

> Shortly after giving the order to 'stop engines' and observing the revolution count had dropped to zero, I moved outside onto the port bridge wing about one meter from the ship's side. It was from this position that I called to the master the next order namely 'slow astern'. I observed the master relaying my order to the crew, although I could not hear him.
>
> On this basis, I disagree that I should be aware of a rudder movement contrary to my orders. I was entitled to assume that my orders had been implemented. I do not consider it part of the pilot's duty, especially during the critical stages of a close quarters-manoeuvre, to maintain a constant watch on the rudder indicator to ensure instructions are complied with, and no unauthorised rudder movements are made by the crew.

In submission the master stated:

> The Master repeats that the pilot, accompanied by the Master, moved to the outside of the port bridge wing where they remained all the time during the turning of the vessel in the Inner Harbour until she was put alongside Berth No. 1 after the contact with Berth No. 2. Therefore, at 1354 (see above) the pilot and the Master were not in the wheelhouse and the Master states no order was received from the pilot at this time to 'stop engine'. Further, the tachometer is not visible from the port side inside of the wheelhouse in any event.

Both the master and the mate stated that no astern order was given until about two minutes before the contact with number two coal loader. According to the master and mate, about three minutes before the contact, the pilot ordered 'slow ahead' and this was recorded in the bell book as being at 1356.

The master stated that, at the time that the engine was put astern at 1358, he thought the ship was moving too rapidly and it was he who ordered the astern movements and that the rudder be put amidships from full starboard rudder. The master's submission continues:

> The Master ordered the pilot to stop the engine and put it astern. The Master acknowledges that the pilot made the 'dead slow astern' and 'slow astern' orders, but only after the Master ordered the pilot to do so. Upon seeing that the orders were not having any effect on the vessel the Master ordered 'full astern' directly to the Chief Officer.

The pilot, however, recalled that it was he who ordered the main engine to stop and then the successive astern movements. He was also under the impression that the engine was slow in going from ahead revolutions to astern revolutions. As discussed later there is no evidence that this was the case.

It should be noted that, at interview, the pilot did not recall ordering *Korimul* to pull the stern to port when off the dolphin south of the grain berth. Rather, his recall is that he only ordered the tug to push the stern to starboard. The port control VHF radio recording provided firm

evidence of the orders given. The pilot would know that the tapes would be provided for evidence and hence his version is not seen as a deliberate attempt to alter the facts.

The significant and critical differences between the accounts of the pilot and the ship's staff mean that one or the other is untrue. The absence of any independent recording of engine movements or the orders given by those on the bridge makes it impossible to verify which account is true.

The only written record of engine movements was made in the bridge bell book. If contemporaneous, this would support the account of the master, mate and helmsman.

The ship's speed

Information taken from the security camera videotape indicates that the ship, while passing through the outer breakwater, travelled its own length in one minute and 35 seconds, giving a speed on entry of 6.1 knots, consistent with the ship's dead slow ahead speed.

The ship was equipped with a doppler log. The mate could not recall any speed, except near, or at, the time of entry, when he recalled seeing a speed of about 5 knots. The pilot stated that as the ship entered the inner basin he checked the speed on the ship's GPS receiver, which read 3.1 knots. The master considered that the speed through the 'Cut' must have been much higher.

These observed speeds are consistent with the distance travelled from the wheel-over position entering the outer harbour at 1334 to the wheel-over position in the inner basin at 1348:30, a distance of about 1780 m. This gives an average speed of 3.978 knots.

Of greater importance is the ship's speed through the turn in the inner basin. A fairly accurate calculation of the speed can be estimated from the video footage from 1355:09 to the time of contact at 1358:05, using the video recorder time. The ship's bow and the two samson posts, situated 99 m and 168 m respectively from the stem and the after part of number seven hatch, 193 m from the stem, were used as reference points. The Inspector has calculated that the ship was decelerating from a speed in excess of 2.8 knots to a speed on contact in excess of 1 knot.

Main engine manoeuvring

The main engine of *SA Fortius* is a 6 cylinder B&W 6S70MC slow speed diesel engine manufactured in Korea by Hyundai Heavy Industries. The main engine is coupled directly to the propeller and is run in reverse to provide the ship with astern thrust. The engine may be controlled from the console on the bridge, which is the usual case both at sea and when manoeuvring in port, from the manoeuvring console in the engine control room and, in an emergency, from the engine side.

The main engine is equipped with a microprocessor-controlled digital engine control system which significantly improves the engine's response times when manoeuvring as compared to a conventional mechanical system. Engine speed, sensed at the flywheel, is compared to the desired speed, set using the engine telegraph, by the microprocessor. The microprocessor controls an electric actuator

First time (from video)	Second time (from video)	Elapsed time	Distance m	m/secknots	
1355:09	1356:17	68 sec	99	1.4588	2.83
1355:09	1357:26	137 sec	168	1.2663	2.28
1356:17	1357:26	69 sec	69	1.0000	1.94
1357:26	1358:05	39 sec	25	0.6410	1.50

(Note: Surveillance video is one minute slow of datum time – add one minute for datum time.)

which in turn drives the engine fuel pump control rack. Any error between the desired and actual engine speeds is quickly rectified by a system with relatively small time constants. This type of engine control system also significantly reduces the chance of a ''false start'.

Advice from the engine designer suggests that the time required to start the engine dead slow astern after it has been running slow ahead would be in the order of 10–20 seconds depending upon how long the propeller 'windmills'. Starting astern from 'stop' would require approximately 10 seconds allowing four seconds for reversing and six seconds to start the engine. After starting astern, the main engine would develop maximum astern power (80 percent of MCR[6]) in approximately 15–20 seconds.

At 1358, the time recorded by the ship's crew for the first astern movement, *SA Fortius*'s speed was approximately 2 knots. At this speed there would not have been a significant amount of propeller 'windmilling' so it is likely that the time taken for the first start astern would have been around 10 seconds. After starting astern, the engine was quickly brought to 'full astern'. Even allowing for the rapid build-up of engine revolutions, it is likely that astern thrust would have been limited by propeller inefficiency and cavitation as the ship was still making headway.

The master/pilot exchange

As a minimum, when a pilot boards a ship, the recommended practice is for the master and the pilot to exchange information. The master should provide the pilot with a pilot card, detailing the ship's characteristics, any particular features of the ship relevant to the ship's handling characteristics and any material deficiency in the ship's equipment or machinery that may impact on the pilot's duties. The pilot in turn should brief the master and other key personnel on the pilotage and the intended manoeuvres involved. The exchange of such information is not a guarantee that accidents will not happen, but the briefing and proper planning reduce the risk of an adverse event. This is a fundamental principle of effective Bridge Resource Management (BRM).

The third edition of the International Chamber of Shipping 'Bridge Procedures Guide', 1998, contains a number of sections pertaining to the master/pilot relationship and the exchange of information. At section 2.6.2, 'Pre-arrival information exchange with the pilot' the Guide states:

> An information exchange initiated by the ship approximately 24 hours before the pilot's ETA will allow sufficient time for more detailed planning to take place both on the ship and ashore. The exchange will also allow communications between the ship and the pilot to be firmly established before embarkation.

At section 3.3.3.3, the Guide covers the master/pilot exchange:

> The preliminary pilotage passage plan prepared in advance by the ship should be immediately discussed and agreed with the pilot after boarding. There should be sufficient time and sea room to allow this to happen.

Such a plan allows a functional bridge team to 'challenge' a pilot if it is believed that the pilot is departing from an agreed plan.

In investigating similar incidents involving port entry or berthing, the Inspector has come across little evidence that the ICS Guide is followed.

Ships' masters and crews and pilots are charged with the safe conduct of high cost ships and valuable cargoes within a port with high cost infrastructure. The time-honoured excuses for incomplete planning, that the ship's staff are not interested and expect the pilot to conduct the ship, or that ship planning is a waste of time as the pilot disregards the ship's plan, are unprofessional and should have no place in shipping operations in pilotage waters.

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6 Maximum Continuous Rating

FIGURE 9:
Portion of pilot's passage plan

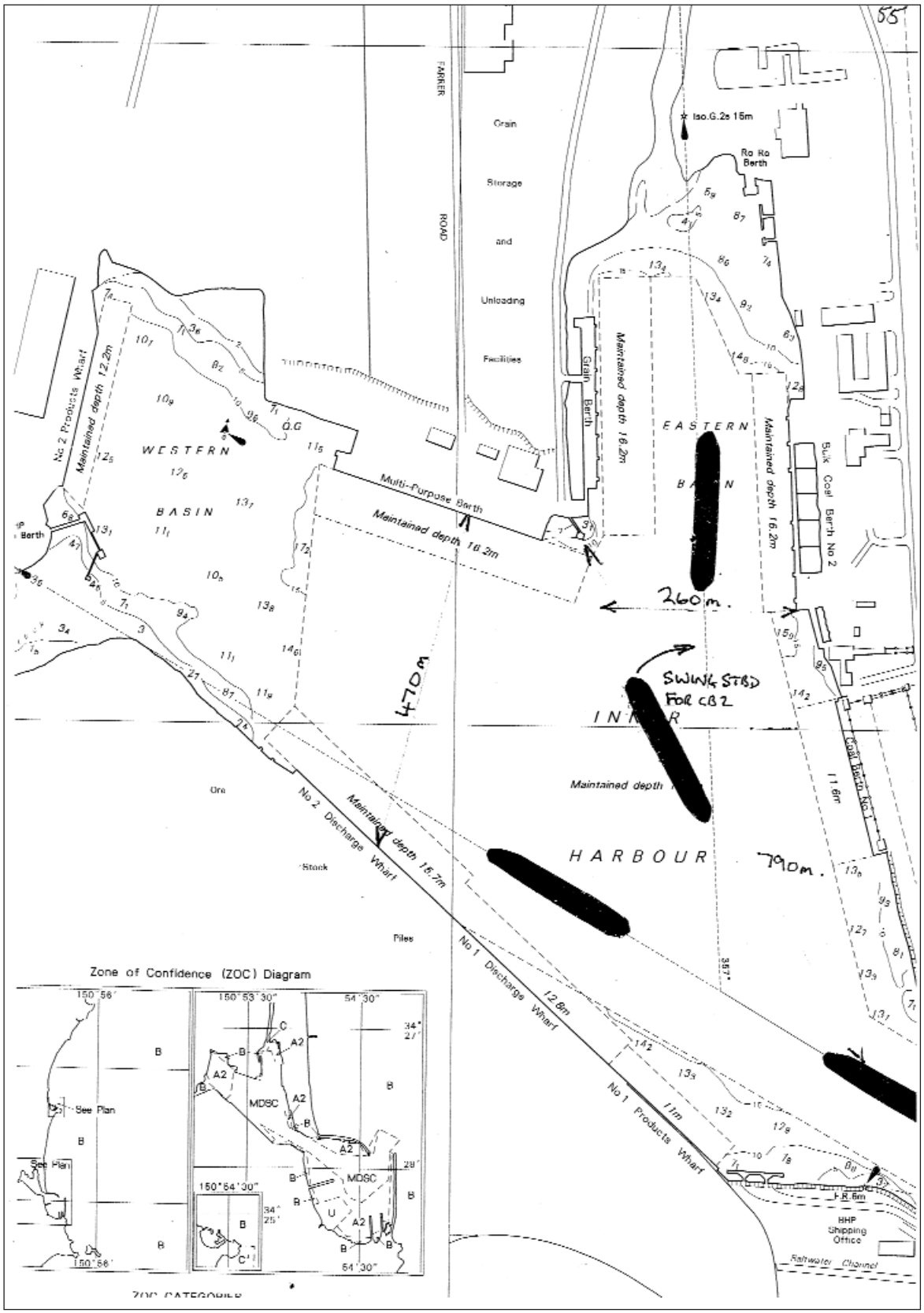
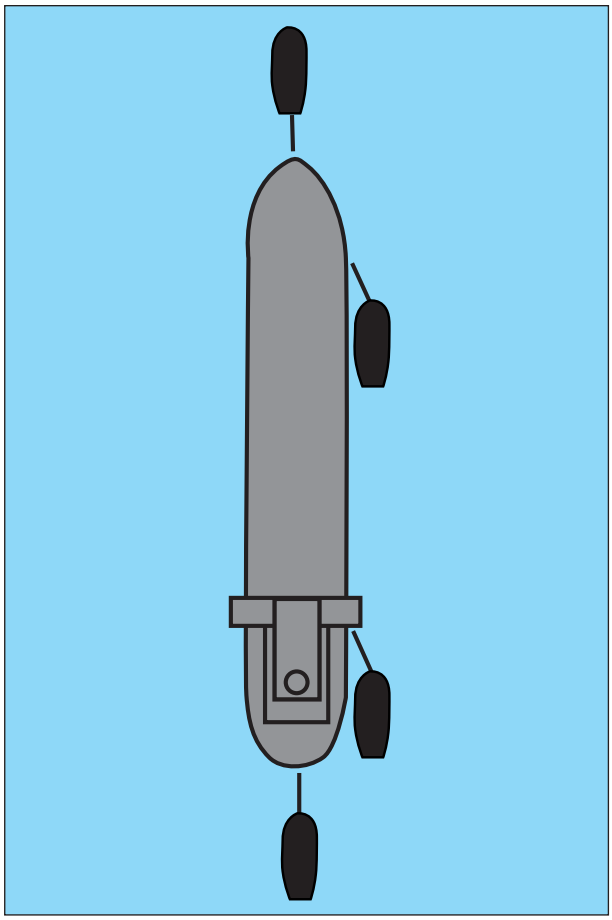


FIGURE 10:
Portion of pilot's passage plan - Disposition of tugs



The International Safety Management Code (ISM Code) procedures carried aboard *SA Fortius* required the ship's staff to complete a 'Pre-Arrival Checklist'. A checklist was completed for the arrival at Port Kembla which was signed by the third mate and countersigned by the master. All relevant items were ticked as being answered in the affirmative.

The first question asked:

> In preparing the passage plan for arrival in port, have the following factors been taken into consideration?
>
> Available port information
>
> Advice/recommendation in sailing directions
>
> Latest weather reports
>
> Tide and current checklist for port and adjacent areas
>
> Calculated/known minimum and maximum depths of water in port approaches, channels and at berth
>
> Any restrictions on draught, trim, speed and entry times, etc.

There is no evidence that the ship's staff prepared a 'berth to berth' passage plan, that is, one including the plans for departure and arrival.

The pilot stated that he showed the master, but not the other deck officers, his own plan for port entry and berthing alongside number two coal loader. The master denied this. There is no corroborative evidence to either support or discount the pilot's statement that he had showed the master a pilotage plan.

Bridge resource management is considered to be so crucial to navigational safety that it is a requirement of Standards of Training, Certification and Watchkeeping '95 (STCW '95) and the International Safety Management (ISM) Code. However, in this incident, the lack of BRM is glaringly evident.

Simulation

To try and better understand the dynamics of the ship's manoeuvres at the time of the incident the ATSB engaged Seasearch, the consultative arm of the Australian Maritime College, to simulate the port entry and berthing of *SA Fortius*. The simulation was based on a time line derived from the orders given to the tugs, the course recorder and the bell book.

Port Kembla Port Authority have used a model of the entrance and the Cut, developed by the simulator staff of the AMC, to train pilots and assess the requirements for night movements into the port. Unfortunately the inner basin is not modelled. However for the purposes of the simulation a general datum depth of 15.25 was

allowed for the inner basin together with the height of tide of 0.6 m. A wind effect of 160° at 0.5 m/sec was also programmed into the model.

The AMC simulator ship model '22802' gave the closest match to *SA Fortius*. The following table provides a comparison between the two vessels.

Dimension	SA Fortius	'Model 22802'
Length	289.08 m	298.5 m
Beam	45.0 m	47.5 m
Draught For'd	9.24 m	9.0 m
Draught Aft	12.05 m	9.3 m
Displacement	111 260 tonnes	103 700 tonnes
Engine	17 098 kW	10 019 kW
Power/displacement	1:6.6	1:10.35
Rudder area	74 m^2	79.3 m^2
Dead slow ahead	6.5 knots	4.3 knots

From the evidence of the simulation, a critical factor appeared to be the amount of stern power exerted by the tugs positioned alongside the ship in counteracting the forward propulsion of the propeller.

The simulation used, as a basis, the engine movements recorded in the bell book and the turning force exerted by the tug on the bow line (40 tonne bollard pull). The forward tug on the starboard side provided astern power, except for the one minute 35 seconds (1355:45 to 1357:20) during which period the pilot had ordered the tug to stop.

With the forward tug on the starboard side on half power astern, the simulation would suggest that, under these circumstances, *SA Fortius* would have turned through some 130° and contacted the eastern inner basin wall between the number one and two coal loaders.

However, with the same tug at quarter power astern (and stopped for one minute 35 seconds) the simulated manoeuvre suggested that the ship would turn further to the north and contact number two coal loader.

Even assuming that the recorded times of the engine movements were accurate to half a minute, variations in ordering engine movements over a sixty second period produced marked variations in the ship's position within the turning basin.

One simulation was completed putting the engine to slow astern, rather than slow ahead, at 1356, three minutes before contact. With this manoeuvre the ship swung just clear of number two coal loader.

Despite significant differences between *SA Fortius* and Model 22802, particularly in relation to engine power and draught, the simulation was useful in the examination of appropriate engine responses to conduct a safe turning manoeuvre.

Pilots and tugs

Communications

Pilot/tug communications, relating to the power required and turning manoeuvres in various ports, are based on the 'custom' at a particular port. Often the 'custom' is based on the mutual understanding between individual pilots and tug masters.

In directing the tugs on 15 April, the pilot did not indicate the power he required from the tugs. The pilot stated that there is a common understanding in the port that any direction given by a pilot to a tug is to be effected at full power unless otherwise indicated.

However, this was not the situation on 15 April.

The master of *Kembla II* used the full 41 tonne bollard pull of the tug when told '*Kembla II*, bow to starboard', at 1351:43, until being told to stop at 1359:16. *Kembla II*'s master stated that he did not usually use full power for ships in ballast, but did so on this occasion as *SA Fortius* was part-loaded.

The master of the tug *Bullara*, which was acting as a braking force, was using about half power in laying back alongside. The pilot was apparently satisfied with the effect *Bullara* was

exerting, however the pilot and tug were working on a different premise. Had the pilot required more braking power, particularly at 1357 when ordering the tug to again '. . . lay back, come astern' about one minute from the contact, it was available.

From the time the tugs were made fast to the time of contact, some 24 minutes later, the pilot gave thirteen orders to the tugs. Three of these orders were to 'stop'. Only one of the directions from the pilot to the tug contained any indication of the power the tug should use. This was the order to *Karoo* at 1359:06, at the time of, or just after, the contact, to '…come astern full power'.

The tug masters interviewed stated that some pilots direct the level of power they require, others do not.

In a letter of 2 December 1999 the Port Kembla Port Corporation wrote to the tug management setting out clear procedures outlining standard orders that pilots would give to tugs and the required communications protocol. The procedures were designed to cover normal operating conditions and did not preclude other orders being given if the need arose. The standard orders were:

1. 'bare weight' – minimum engine power to exert a force on the ship.
2. 'easy' – 25 per cent of the tug's normal operating power.
3. 'half' – 50 per cent of the tug's normal operating power.
4. 'full' – 100 per cent of the tug's normal operating power.

Tug masters were required to respond by repeating the order back.

On 15 April the tug masters repeated back the pilot's orders in accordance with the standard. But the pilot did not indicate the standard setting required of the tug until after the contact.

In the Inspector's opinion, given the development in tug propulsion and power, a degree of certainty would be generated if the procedures (or similar procedures) in the Port Kembla Port Corporation letter of December 1999 were adopted as a standard.

Towline breakages

The line from the tug *Karoo* parted about one minute after *SA Fortius* contacted number two coal berth. Hence the breaking of the line did not contribute to the accident. The tow line in use was a 72 mm polypropylene tow rope, Marlow Superline (mean breaking load 123 tonnes) with a Marlow Superline 56 mm polypropylene grommet. The tug's bollard pull of 47.9 tonnes was well within the tow line specification.

In submission Adsteam Towage Pty Ltd stated:

> Prior to the tugs being engaged, following standard company procedures, the line was visually inspected on the day of 15 April 2002 and following this visual inspection no evidence was found of damage.
>
> Further Adsteam would like to categorically state that Adsteam take very seriously the issue of tug line breakages. Adsteam undertakes an internal investigation of each incident of line breakage and if the findings of those investigations warrant further consideration and analysis, photos and samples are sent to Marlow, the manufacturer, for advice and feedback.

Port Kembla pilots provided the Inspector with records showing that they had recorded 26 towline breakages since 1997, at an average rate (1997-2001) of 4.6 breakages per year. The suggestion by the pilots was that the breakages were due, in part, to the length of the towline. A simple analysis of the breakages shows that the position of the tug (whether on the shoulder, alongside aft, towing at the bow or the after tug) is immaterial, with comparable breakage rates at all four positions. This would suggest that the line length makes little difference, based on the assumption that the head line tug and stern line tug use a greater length of tow line than the tugs alongside.

The tug operators attribute the rate of line breakage to the specific conditions of the port. Tugs make fast and let go off Port Kembla in an

open seaway, which is subject to heavy swells. This causes significant wear of the towlines.

What was evident, however, was confusion as to who controlled the length of the towline on board the tug and how. Information from the pilots was that the tug deckhands controlled the length of the towline at the direction of the master. The tug masters told the Inspector that it was the tug masters who controlled the length of line from the winch controls on the bridge manoeuvring console.

Both the pilots and the tug masters told the Inspector that there had formerly been regular meetings between the pilots and tug masters. The meetings had, however, become formalised with both port and tug management participation and this hindered the two-way flow of information or any spontaneity. Communications between the two parties had suffered as a result.

Medium ballast/part loaded – Heavy ballast/part loaded

Between January 1996 and 15 April 2002, 265 capesize bulk carriers had been berthed at number two coal loader. A total of 90 capesize carriers were classed as being 'medium ballast/part loaded' or 'heavy ballast/part loaded'. Sixty six of these had a deepest draught between 9.0 m and 9.99 m and were classed as 'medium ballast/part loaded'. A further 24 had a deepest draught in excess of 10.0 m and were classed as 'heavy ballast/part loaded'. Of the 24 'heavy ballast/part loaded' ships, six had used number two coal loader as a 'lay-by' berth before moving to an iron ore discharge berth, without swinging in the inner basin.

In all, eighteen 'heavy ballast/part loaded' cape size bulk carriers were required to swing in the inner basin and berth port side to number two coal loader in a six year and four month period. Five of these 'heavy ballast/part loaded' ships had a mean draught in excess of 10.0 m. *SA Fortius* with a mean draught of 10.655 m was the sixth such ship.

From the time he obtained his unrestricted pilot's licence (class four) for Port Kembla in 1997, to the time of the incident, the pilot had berthed 43 capesize bulk carriers at number two coal loader. Sixteen of these are classified as 'medium ballast/part loaded' and three as 'heavy ballast/part loaded'. The three 'heavy' vessels were all marginally over 10.0 m maximum draught aft, with the last of these being piloted in September 2001.

SA Fortius, at a deepest draught of 12.07 m and with a mean draught of 10.655 m, was the largest vessel the pilot had been required to swing in the inner harbour and berth alongside number two coal loader. In terms of mean draught, *SA Fortius* was a metre deeper than any previous ship that the pilot had been required to turn and berth at the coal loader.

In submission the pilot stated:

> It should be noted that the departure of part laden and ballasted Capesized vessels from BHP's number 2 discharge berth is, in the opinion of the pilots in the port, a far more difficult manoeuvre than berthing inward vessels to coal berth No.2. In terms of assessing pilots' experience, these movements should properly be added to the figures used . . .

Vessels sailing from BHP's number 2 discharge berth, 'head in', must be turned off the berth before proceeding to sea. According to figures supplied by the Port Kembla Port Corporation, between 1 January 1996 and 31 December 2001, 88 'heavy ballast/part loaded' or fully loaded ships sailed from BHP's number two discharge berth. The pilot on duty on 15 April handled ten such vessels, of which eight had a mean draught in excess of 11m.

Aids to piloting

Port Kembla pilots do not use any electronic chart/GPS systems to aid in the berthing of large ships. The pilot had no independent means of recording the planned or the actual passage.

With the increasing size of bulk carriers utilising Port Kembla a 'Computer Aided Pilot System' (CAPS) was introduced for the pilots'

use. However, the size of the unit made it inconvenient to take on board and its reliability was an issue for the pilots. The pilots stopped using the system.

The pilot on board *SA Fortius* had no technological assistance in establishing his relative positions during a pilotage. There is little doubt that, had the pilot had some form of GPS based system with a track projection/motion predictor programme, he would have had an earlier indication of possible problems. He would then have been in a position to rectify the situation.

Ship/port simulation provides an effective training tool for pilots. Modern simulators accurately reproduce ship responses in accurately modelled ports. Although each individual ship will behave differently, simulation using a number of 'typical ships' allows pilots to experiment and try manoeuvres that a real-life situation makes impractical. Also, simulation allows for practice in responding to engine or equipment failures and other emergency manoeuvres. It maintains or enhances the pilots' expertise as well as allowing for innovation.

Fatigue and drugs

The pilot had returned from a short period of leave. He was not on any course of medication and there is no suggestion that he was taking self-prescribed medication or illicit drugs. There was no evidence of alcohol usage.

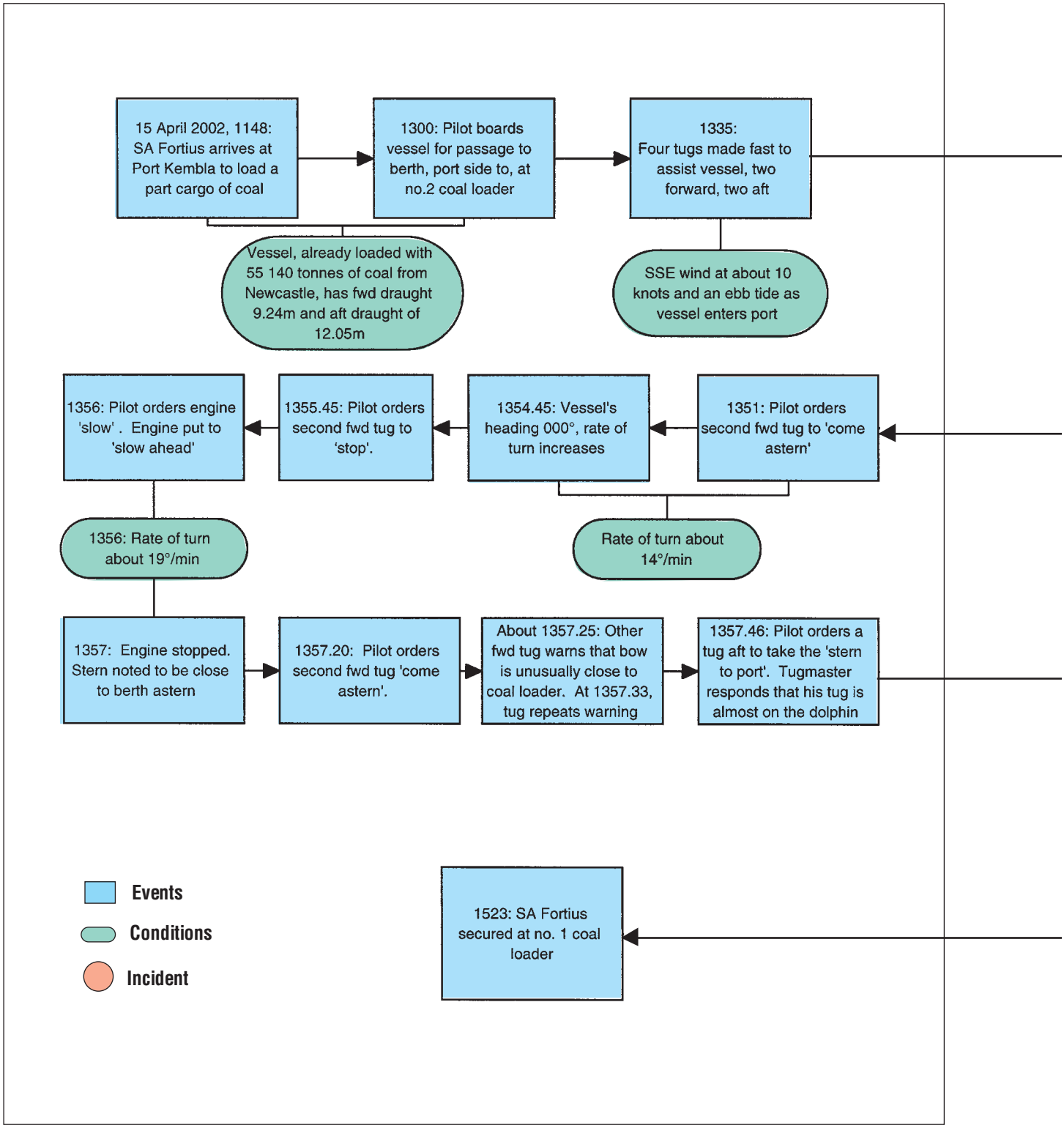
The ship's crew had sailed from Newcastle at 0408 on 15 April, following loading operations over the preceding eighteen hours. Their hours of duty over the preceding two days based on a simple sleep credit/debit basis[7] would have meant that both the master and mate probably had either zero score or a marginal sleep debit. They were probably tired but not to an extent that there would have been a decrement in their performance.

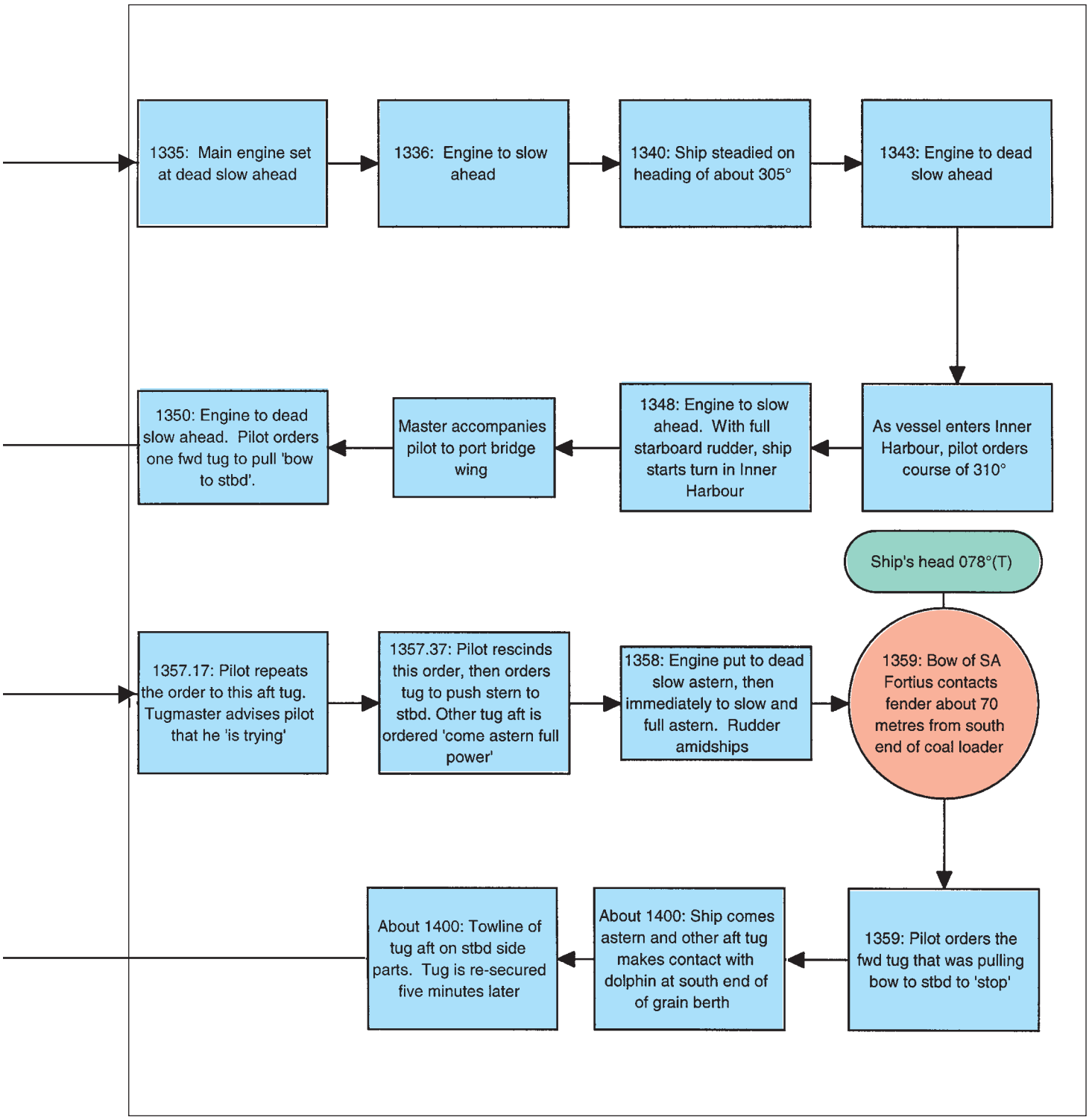
There was no evidence of alcohol, or prescribed or illicit drug use by the ship's staff.

[7] Sleep credit/debit scores 2 credit points for every hour asleep and 1 debit point for every hour awake

FIGURE 11:

SA Fortius **Events and causal factors chart**




1335: Main engine set at dead slow ahead
1336: Engine to slow ahead
1340: Ship steadied on heading of about 305°
1343: Engine to dead slow ahead
As vessel enters Inner Harbour, pilot orders course of 310°
1348: Engine to slow ahead. With full starboard rudder, ship starts turn in Inner Harbour
Master accompanies pilot to port bridge wing
1350: Engine to dead slow ahead. Pilot orders one fwd tug to pull 'bow to stbd'.
Ship's head 078°(T)
1359: Bow of SA Fortius contacts fender about 70 metres from south end of coal loader
1358: Engine put to dead slow astern, then immediately to slow and full astern. Rudder amidships
1357.37: Pilot rescinds this order, then orders tug to push stern to stbd. Other tug aft is ordered 'come astern full power'
1357.17: Pilot repeats the order to this aft tug. Tugmaster advises pilot that he 'is trying'
1359: Pilot orders the fwd tug that was pulling bow to stbd to 'stop'
About 1400: Ship comes astern and other aft tug makes contact with dolphin at south end of of grain berth
About 1400: Towline of tug aft on stbd side parts. Tug is re-secured five minutes later

Conclusions

These conclusions identify the different factors contributing to the incident and should not be read as apportioning blame or liability to any particular individual or organisation.

There was no evidence to suggest that *SA Fortius* experienced any equipment failure or that the engine and other machinery were a causal factor in the contact. Based on the evidence available, the following factors are considered to have contributed to the incident:

1. *SA Fortius* developed a large drift angle, which resulted in the ship being too far to the north in the turning basin.
2. The drift angle was not detected by the pilot.
3. The engine was put to 'slow ahead' at about 1356, when the intended engine order was 'slow astern'.
4. The pilot did not take sufficient notice of the tachometer and rudder angle indicator.
5. The bridge team work was negligible, resulting in a breakdown of effective and safe communications between the pilot and the ship's staff on the bridge.
6. The master did not take sufficient steps to ensure that he was aware of the intended manoeuvre in the inner basin.
7. There was a lack of specific direction to the tugs by the pilot. He did not follow the 'Standard Orders to Tugs' issued by the Port Kembla Port Corporation in December 1999.

Although not contributory factors, it is also considered that:

- The practice of recording engine movements to the nearest minute is inappropriate when manoeuvring in confined waters.
- The maintenance of the ship's bell book was of a low standard.

Recommendations

MR20030007
Pilots use the procedures as laid out in 'Standard Orders to Tugs' issued by the Port Kembla Port Corporation in December 1999, when directing tug manoeuvres.

MR20030008
Port authorities, where not otherwise equipped, should consider the introduction of an electronic aid, with track prediction capability, to assist pilots with the berthing of ships.

MR20030009
All ports should consider publishing their general port entry and berthing manoeuvre plans on the Internet. This would provide port users with direct access to port information (or indirect access through ship's agents), permitting masters and officers to plan passages as recommended in the International Chamber of Shipping's 'Bridge Procedures Guide'.

MR20030010
Periodic meetings between pilots and tug masters be reintroduced at an operational level.

MR20030011
When piloting ships, pilots should consider means by which they can verify all orders given by them.

Submissions

Under sub-regulation 16(3) of the Navigation (Marine Casualty) Regulations, if a report, or part of a report, relates to a person's affairs to a material extent, the Inspector must, if it is reasonable to do so, give that person a copy of the report or the relevant part of the report. Sub-regulation 16(4) provides that such a person may provide written comments or information relating to the report.

The final draft of the report, or relevant parts thereof, was sent to:

The master, mate and the ship managers of *SA Fortius;*

The pilot;

The harbour master, Port Kembla Port Corporation;

Regional Manager, Southern NSW, Adsteam Towage Pty Ltd trading as Adsteam Harbour Port Kembla;

The tug masters, *Kembla II*, *Bullara*, *Karoo* and *Korimul*.

Where appropriate the text has been change to correct the draft or reflect the submission.

With respect to the conclusions, the master, mate and the owners submitted:

> The Master, the Chief Officer and Owners all strongly disagree with conclusions 5 and 6 in the report referring to bridge teamwork and alleged insufficient steps taken by the Master to make himself aware of the intended manoeuvres of the pilot. The Master states that the vessel's own pilot card showing, inter alia, the vessel to be partly laden with a declared deadweight of 88 674 tonnes was provided to the pilot but that no documentation was received in return. When the Master did request information of the pilot, the pilot failed to inform the Master properly, or inform him at all of intended manoeuvres. The Master indicates that 'communications' is a two way dialogue and when faced with a failure by the pilot to provide information despite repeated requests, that this does not amount to a failure by the Master to take sufficient steps to ensure that he was aware of the intended manoeuvres in the basin.

In addition to those submissions included in the text of the report, the pilot also submitted, in relation to the conclusions:

> In relation to your first conclusion, I disagree that the vessel was too far to the north in the turning basin. The vessel was within the usual turning zone for this manoeuvre.
>
> In relation to conclusion 2, I deny that I did not detect the drift angle. I did detect the drift angle and for this reason gave the order around 1355 for the engines to be stopped and then for 'slow astern'.
>
> In relation to conclusion 4, I believe I took reasonable notice of the tachometer and rudder angle indicator, having regard to the position of those devices on the bridge, and my judgement that it was important to remain stationed on the bridgewings at the critical times in order to monitor the vessel's position relative to the fixed land structures. I believe I was entitled to assume my orders were being complied with by the ship's officers.
>
> In relation to conclusion 5, if there was a problem with the bridge team work, it arose because my orders were ignored and counter-manded by the master without him informing me of his decision.
>
> In relation to conclusion 7, I disagree that the tugs were operating on different criteria to me. There is a common understanding in the Port that orders in relation to fully laden or partly laden Capesize vessels are to be effected at full power unless otherwise stated. In any event, the power utilisation of the tugs does not appear from your report to have played any role in the incident, and I therefore question the appropriateness of this conclusion in a report examining the causes of the casualty.

SA Fortius

IMO Number	9221217
Flag	Bahamas
Port of Registry	Nassau
Classification Society	Bureau Veritas
Ship Type	Bulk Carrier
Builder	Hyundai Heavy Industries Co.Ltd., Ulsan, Korea
Year Built	2001
Owners	Braverus Maritime Inc
Ship Managers	Enterprise Shipping and Trading SA
Gross Tonnage	87 542
Net Tonnage	56 714
Deadweight (summer)	171 509 tonnes
Summer draught	17.721 m
Length overall	289.08 m
Breadth	45.0 m
Moulded depth	24.10 m
Engine	Hyundai-B&W 6S70MC
Total power	17 098 kW
Crew	21, Polish (1) Ukrainian (20)