Australian Government
Australian Transport Safety Bureau

Collision between the Liberian bulk carrier *Grand Rodosi* and the Australian fishing vessel *Apollo S*

Port Lincoln, South Australia | 8 October 2010

Investigation

ATSB Transport Safety Report
Marine Occurrence Investigation
279-MO-2010-008
Final

Australian Government

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ATSB TRANSPORT SAFETY REPORT

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SAFETY SUMMARY

What happened

At about 1450 on 8 October 2010, the partially loaded Liberian registered bulk carrier *Grand Rodosi* collided with the Australian fishing vessel *Apollo S* in Port Lincoln, South Australia. As a result of the collision, *Apollo S*, which was unmanned, was crushed against the wharf and sank shortly afterwards. *Grand Rodosi* sustained several relatively small holes in its bow shell plating.

What the ATSB found

The ATSB investigation found that, despite the pilot ordering astern movements, the ship's main engine did not run astern in the 5 minutes leading up to the collision. The chief engineer, who was operating the main engine start/fuel lever in the engine room control room, did not allow sufficient time for starting air to stop the ahead running engine. Consequently, when fuel was introduced into the engine, it continued to run ahead, despite the astern telegraph orders.

The investigation also found that the chief engineer's mistake was not identified by anyone on the ship's bridge or in the engine room control room until after the collision; that the master/pilot information exchange was less than optimal; and that bridge resource management principles could have been better applied during the passage to the berth.

What has been done as a result

Newlead Bulkers, the ship's managers, have amended their on board procedures to ensure crew monitor the direction of main engine turning after each engine order. They have also increased awareness through their fleet about this type of incident occurring.

Flinders Ports, the provider of pilotage services in Port Lincoln, have revised their risk assessment for the manoeuvre being undertaken during *Grand Rodosi*'s berthing to include new preventative, as well as restorative, measures to be followed. Flinders Ports has also revised the port's pilotage passage plan to include indicative courses to be followed, both while transiting the channel and outside of it, and speed zones. This will enable the crews of visiting ship to be better informed about the pilotage passage their ship is about to undertake.

Safety message

It is of paramount importance that pilots and ships' crews maintain awareness of main engine movements and check engine tachometers following every movement to ensure that the engine is operating in the desired direction. This is particularly important when main engines are being operated in manual control.

In addition, pilots and the bridge teams should ensure that all the necessary information is exchanged at the beginning of a pilotage, including courses to be followed and speeds at critical positions during the passage to or from the berth/anchorage, so that all members involved in the pilotage have a shared mental model and therefore, a good understand of the pilotage before it begins.

CONTENTS

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Investigation into the collision between the Liberian registered bulk carrier *Grand Rodosi* and the Australian fishing vessel *Apollo S* at Port Lincoln, South Australia, on 8 October 2010.

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Acknowledgements

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The cover photograph was obtained from CargoLaw.com. Figure 1 is provided courtesy of Les Blair. Figure 5 was taken from *Apollo S*'s 2005 condition and evaluation report, as provided by Coates Lawyers, Port Lincoln. Figure 11 was provided courtesy of Barry Ellis and Figure 16 was obtained from the Nautical Institute's '*Tug use in ports – a practical guide*'.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes appropriate, or to raise general awareness of important safety information in the industry. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: The ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

1 FACTUAL INFORMATION

1.1 *Grand Rodosi*

Grand Rodosi (Figure 1) is a conventional, gearless panamax[1] bulk carrier with seven cargo holds located forward of the accommodation superstructure. The ship was built in 1990 by Hyundai Heavy Industries, Korea. It has an overall length of 225 m, a moulded breadth of 32.2 m, a moulded depth of 18.3 m and, at a summer draught of 13.22 m, it has a deadweight of 68,788 tonnes.

Figure 1: *Grand Rodosi*

The ship's propulsive power is provided by a MAN B&W 6S60MC single acting, direct reversing, two-stroke diesel engine. The engine develops 8,994 kW at 84 rpm and drives a fixed pitch propeller, giving the ship a service speed of about 14 knots[2]. The ship had been built to operate with an unmanned machinery space (UMS) classification[3] but at the time of the incident, all main engine manoeuvring was being conducted in engine room control mode.

At the time of the incident, *Grand Rodosi* was owned by Grand Rodosi Inc, Liberia. It was managed by Newlead Bulkers, Greece, registered in Liberia and classed with Bureau Veritas (BV).

Grand Rodosi's bridge was equipped with navigational equipment in accordance with SOLAS[4] requirements. This included a JRC simplified voyage data recorder (S-VDR).

The ship's crew consisted of 24 Filipino nationals. All the crew were appropriately qualified to hold their positions on board the ship.

The master had 30 years of seagoing experience. In 2000, he obtained his Philippines master's certificate of competency and he had been sailing as master since that time. He joined *Grand Rodosi* for the first time on 9 September 2010. This was his first visit to Port Lincoln.

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1 A ship that is limited in size to the dimensions of the Panama Canal.

2 One knot, or one nautical mile per hour equals 1.852 kilometres per hour.

3 A class notation indicating the ship may be operated with the machinery spaces periodically unattended.

4 The International Convention for the Safety of Life at Sea, 1974, as amended.

The third mate, the duty bridge watchkeeper at the time of the collision, began his seagoing career in 2000. In 2004, he obtained his Philippines third mate's certificate of competency and he first sailed as third mate in 2005. He joined *Grand Rodosi* for the first time on 8 August 2010.

The chief engineer had 38 years of seagoing experience. He obtained his chief engineer's certificate of competency in 1990 and had been sailing as chief engineer since that time. He joined *Grand Rodosi* for the first time on 9 July 2010.

1.1.1 Main engine control system

In March 2009, *Grand Rodosi*'s UMS[5] classification with BV was removed at the request of its operators. As a result, the ship was operated with a manned engine room from that time. With the engine room being manned, the decision was taken by Newlead Bulkers not to use the ship's Norcontrol AutoChief III bridge control system which provided direct control of the main engine from the bridge telegraph/control unit. Consequently, at the time of the incident, *Grand Rodosi*'s main engine was being operated by the ship's engineers from the engine room control room with the bridge control unit operating as a telegraph.

Engine room control of the main engine

In order to obtain the required engine movement, the bridge telegraph lever (Figure 2a) was moved to the desired position. An alarm then sounded on the bridge and in the engine room control room and continued to sound until the engine room control (ERC) telegraph (Figure 2b) was turned (ahead or astern) to match that bridge order. When that happened, the alarm stopped and the appropriate light on the bridge and ERC telegraphs remained lit to indicate that the requested movement had been acknowledged.

Figures 2a & b: Bridge and ERC telegraphs

The ERC telegraph was responsible for the actual direction of the main engine rotation as it altered the timing of the fuel pump cams and air start distributor.

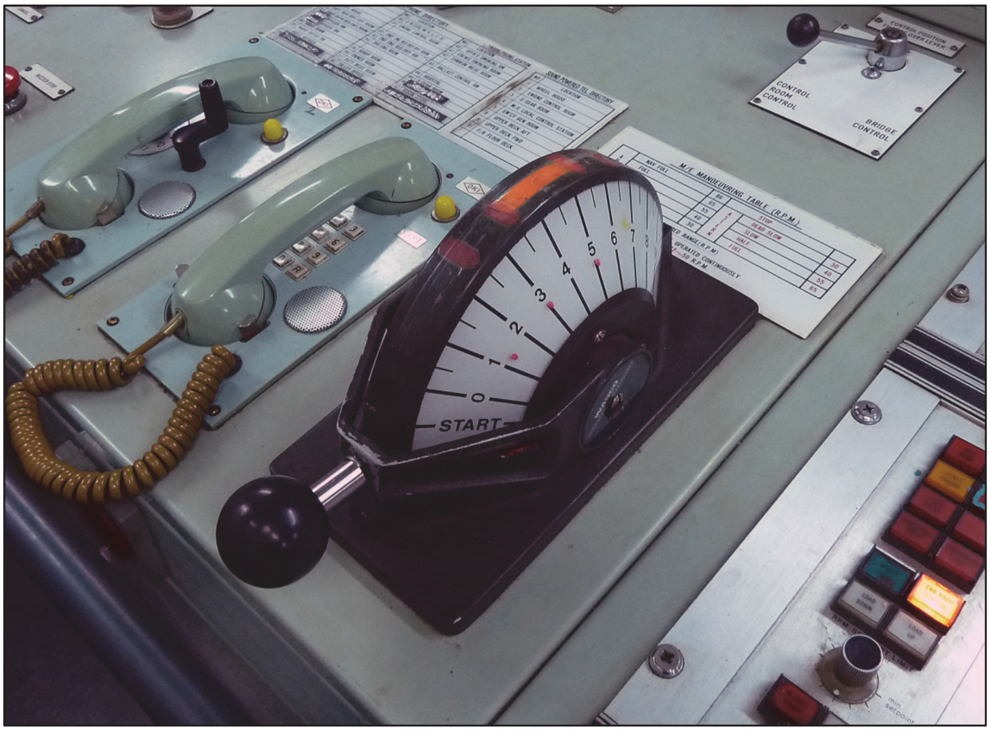
When a change of direction (e.g. ahead to astern) was requested, the operating system controlled by the ERC telegraph, through the main engine air start

[5] A class notation indicating ship may be operated with the machinery spaces periodically unattended.

distributor, distributed air via the air start valves to the combustion chambers of the main engine, in the sequence for the selected direction of rotation. At the same time, the fuel cam rollers on each fuel pump moved to correspond with the requested direction of rotation and firing order.

Following the movement of the ERC telegraph, when the start/fuel lever (Figure 3) was moved from the stop position to the start position, 'starting' air was admitted to the cylinders and the engine turned over on air. The order of air admitted to the combustion chambers depended on the desired direction of rotation for the main engine (ahead or astern). When the start/fuel lever was moved past the start position, the supply of starting air was shut off and fuel was admitted to the cylinders and the engine began to run on fuel. The speed of the engine was controlled by the amount of fuel admitted to each combustion chamber.

Figure 3: The start/fuel lever in the stop position



If the engine was turning in the opposite direction to that requested by the telegraph, when the start/fuel lever was moved to the start position, the introduced air became 'braking air'. The operator then needed to hold the braking air on until the engine stopped rotating. Once the engine was stopped, the air would then start to turn the engine in the direction ordered and then fuel could be introduced into the engine, as discussed above.

To help the operator of the start/fuel lever determine the position of the fuel cams, there are fuel cam position indicators mounted in the main engine indicator panel on the control console in the engine room control room. These indicators are located immediately above the Norcontrol system panel on the console, just above and to the right of the start/fuel lever.

Regardless of the position of the telegraph and the fuel pump cams, if insufficient time is spent in the start position to allow the engine to come to a stop on braking air, when the start/fuel lever is moved from the start position, fuel will be admitted and the engine will fire and continue to rotate in its current direction. If this were to happen, the main engine will run but at reduced efficiency.

Should this occur, the alarm and monitoring system is designed to detect the discrepancy between the telegraph order and the actual direction of rotation and a flashing visual ‘wrong way’ alarm on the ERC and bridge telegraph consoles is activated (Figures 2 a & b). However, when the main engine is operated from the engine room control room, the Norcontrol AutoChief III bridge control system’s ‘wrong way’ running interlock and audible alarm protections are by-passed.

1.1.2 Engine telegraph data logger

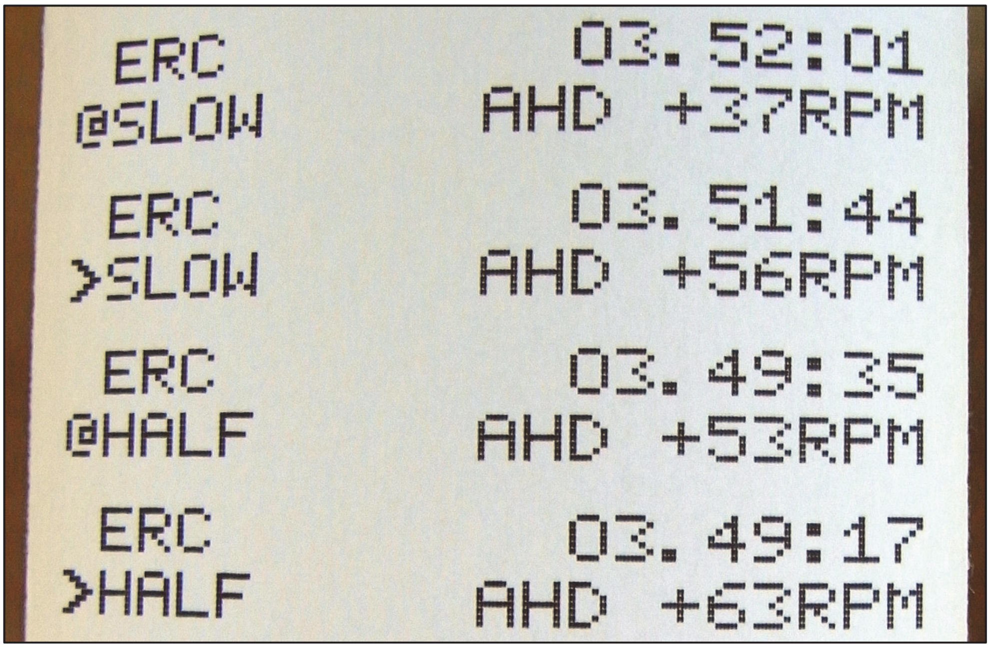
Located below the main engine telegraph on *Grand Rodosi*’s bridge was an engine telegraph data logger. The data logger recorded the movements of the bridge telegraph and the ERC telegraph in response to the bridge telegraph’s movement. There was no similar data recorder in the engine control room. A manual record of engine telegraph movements was also kept on the bridge and in the engine room control room.

When an engine movement was ordered from the bridge telegraph (indicated on the printout by the ‘>’ symbol), the data logger recorded the time of the request, what the requested movement was (e.g. HALF AHD) and the actual engine rpm at the time (Figure 4).

When the ERC telegraph acknowledged the request (indicated on the printout by the ‘@’ symbol), the data logger recorded the time and the engine rpm.

Ahead and astern rpm movements were indicated on the printout by the ‘+’ and ‘-’ symbols respectively.

Figure 4: Sample of engine data logger printout



1.2 *Apollo S*

Apollo S (Figure 5) was a specialised purse seine[6] steel fishing vessel which was built in 2003 by Port Lincoln Marine Services. It had an overall length of 46.95 m, a breadth of 10.7 m, a depth of 6.92 m and a gross tonnage of 1,008.

The vessel's propulsive power was provided by a four stroke Wartsila 9L20 diesel engine that developed 1,500 kW at 1,000 rpm. The engine drove a controllable pitch propeller which gave the vessel a service speed of about 13 knots.

Apollo S was owned and operated by Australian Fishing Enterprises, Port Lincoln, classed with the American Bureau of Shipping (ABS) and registered in Australia. It was in survey as a Uniform Shipping Laws (USL) Code Class 3B fishing vessel[7] and was certified to carry up to 14 crew.

Figure 5: *Apollo S* berthed in Port Lincoln

1.3 Port Lincoln

Port Lincoln (34° 43'S 135° 56'E) is a deep water port located on the western shores of Spencer Gulf, about 150 miles west of Adelaide, the capital of South Australia. The port is an import/export hub for the surrounding area and it is also the base for a large fishing industry.

The port's primary export commodity is unmilled grains and its imports predominately are coal tar, pitch, crude oil and fertilisers. In the financial year

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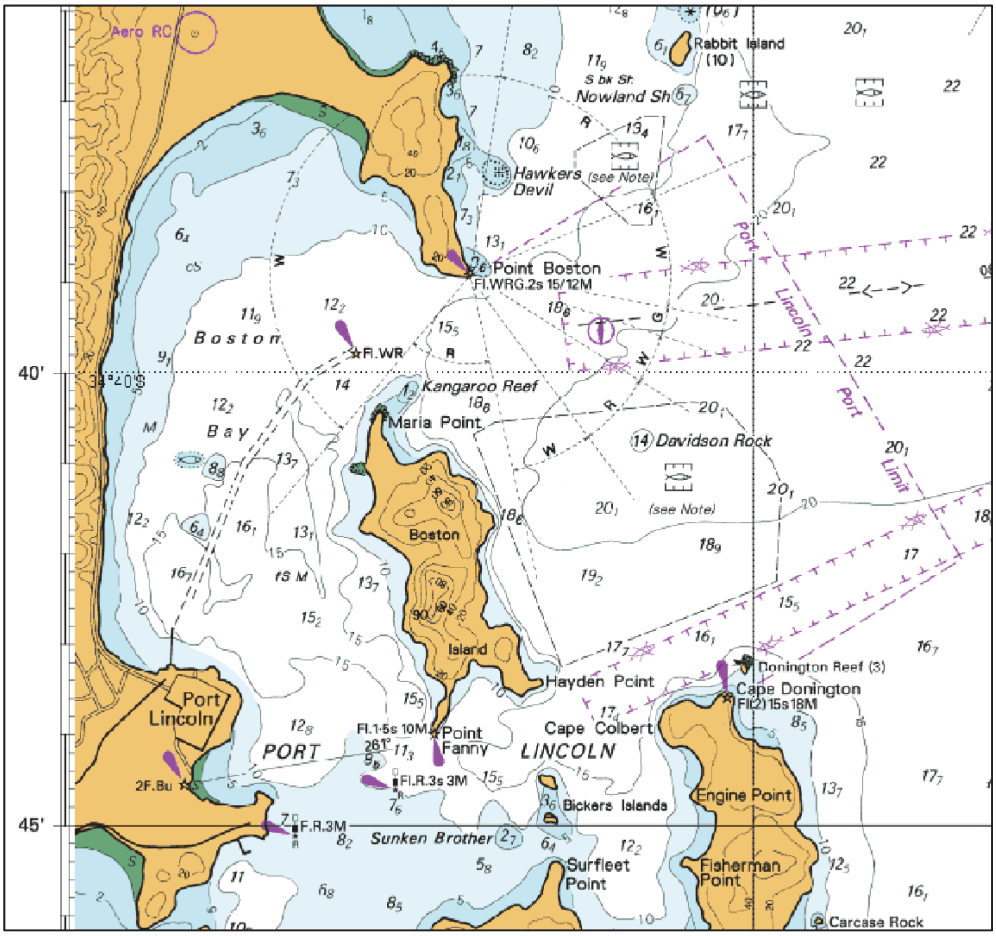
6 A fishing technique which utilises a large net that encloses a school of fish and is then closed at the bottom by means of a line resembling the string formerly used to draw shut the neck of a money pouch or purse.

7 A seagoing fishing vessel for use in all operational areas up to and including offshore operations (within 200 miles of the coast).

2010/11, 2.79 million tonnes of cargo was moved through the port, of which 2.125 million tonnes was grain exports[8].

Port Lincoln's port limits include the waters, rivers, creeks and inlets of Spencer Gulf within a line drawn 3 miles[9] seaward of a straight line between Cape Donington and Point Boston (Figure 6). While Port Lincoln can be approached either north or south of Boston Island, the preferred approach is to the north of Boston Island. From there, a dredged channel, with a maintained depth of 14.6 m, is marked by beacons and leads to the port's principal wharves.

Figure 6: Section of navigational chart Aus 134 showing Port Lincoln and its approaches



Port Lincoln is operated by Flinders Ports, a private company which also operates the South Australian ports of Port Adelaide, Port Pirie, Port Giles, Klein Point, Thevenard and Wallaroo. Pilotage in Port Lincoln is compulsory for all ships of 35 m or more in length, unless they are under the command of a master who holds a valid pilotage exemption for the port.

While tides in Spencer Gulf generally flow in a northerly direction on a flood tide and in a southerly direction on an ebb tide, tidal flow within Port Lincoln is not significant.

8 SA Department of Planning, Transport and Infrastructure: *Introduction to South Australian sea exports/imports (Financial year 2010-11).* March 2012.

9 A nautical mile of 1852 m.

To assist with berthing ships, the port has two 1,794 kW conventional, twin propeller tugs; the 29 m *Kioloa,* with a 'bollard pull'[10] of 40 tonnes and the 30 m *Wangary*, with a bollard pull of 43.4 tonnes. Each tug is equipped with propellers mounted in Kort nozzles; fixed on *Kioloa* and steerable on *Wangary.*

1.3.1 The Port Lincoln pilot

The pilot on board *Grand Rodosi* for its transit into Port Lincoln began his seagoing career in 1989. In 1997, he gained an Indian master's certificate of competency and started sailing at that rank. He continued sailing as master until late 2005, when he joined Singapore Pilots. He worked as a pilot in Singapore, completing over 3,000 shipping movements, until October 2009, when he joined Flinders Ports. Since that time, he had completed bridge resource management (BRM) and advanced marine pilot training, manned model training at the Australian Ship Handling Centre (Port Ash), New South Wales, and bridge simulator training at the Australian Maritime College, Tasmania. He had also undergone on-the-job training at each of Flinders Ports managed ports. At the time of the incident, he held pilot licences for the ports of Port Lincoln, Thevenard and Whyalla.

During his time as a pilot with Flinders Ports, he had undertaken 15 observer trips of pilotages in Port Lincoln. After that, he had undertaken 8 mentored and 2 checked trips as a pilot. After gaining his piloting licence for the port, he had undertaken 48 pilotages, 25 of which had been inbound.

1.4 The incident

On the morning of 8 October 2010, the bulk carrier *Grand Rodosi* was at anchor off Port Lincoln. The ship had anchored on 3 October, following a voyage from Brisbane, Queensland, where it had part loaded a cargo of grain. *Grand Rodosi* was scheduled to berth at Port Lincoln's bulk grain loading berth on the afternoon of 8 October to complete loading in Australia.

A Port Lincoln harbour pilot was scheduled to board the ship at 1400[11] and, in preparation for the boarding, the ship's main engine was tested ahead and astern. At 1315, the main engine was placed on standby and the crew commenced weighing anchor.

By 1340, the anchor was aweigh and the master began to manoeuvre the ship towards the pilot boarding ground. During the short trip from the anchorage, the master again tested the main engine; running it dead slow ahead, stopping it and then running it up to half astern before stopping it again.

In the engine room control room for the passage to the berth, the chief engineer was moving the main engine start/fuel lever and the electrical engineer was answering the bridge telegraph orders on the ERC telegraph. The fourth engineer was also in the control room and two other engineers were in the engine room.

Just after 1400, the harbour pilot boarded the ship and made his way to the bridge. When he got to the bridge, he was greeted by the master. The pilot then ordered half

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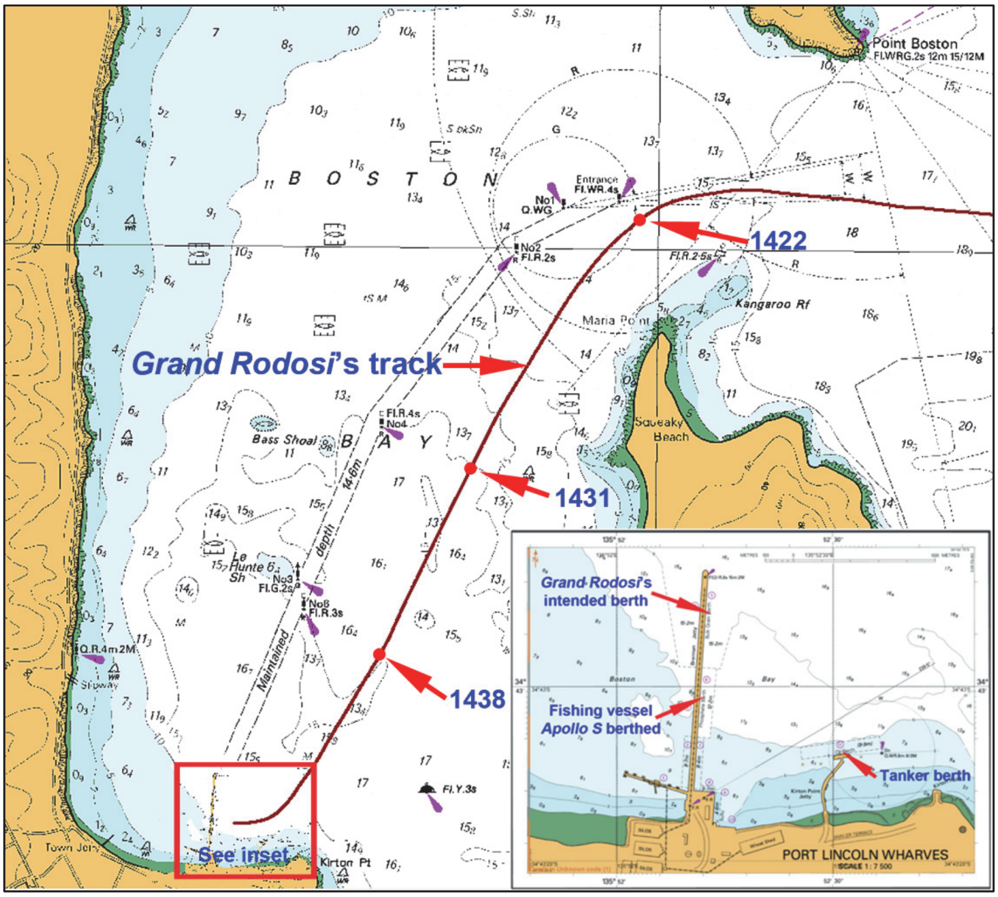
10 A measure of the pulling power of a tug, expressed in tonnes.

11 All times referred to in this report are local time, Coordinated Universal Time (UTC) + 10½ hours.

ahead on the main engine and a heading of 270° (T) to be steered. At 1406, the master and pilot began their information exchange. During the information exchange, the pilot ascertained that the main engine had been tested and that the ship's anchors had been cleared and were ready for letting go. He was also told of the ship's arrival draughts; 6.2 m forward and 10.93 m aft but he was not told that the ship's main engine was being manually controlled by ship's staff.

With an after draught of less than 11 m, the pilot decided to take the ship outside the channel, keeping the channel beacons on the ship's starboard side. After passing the channel's entrance beacon, his plan was to steer the ship towards the Kirton Point tanker berth (Figure 7), and then, as the ship approached the tanker berth, turn it to starboard before berthing it port side to the number 5 berth on Brennan Jetty.

Figure 7: Section of navigational chart Aus 134 showing the actual passage through Boston Bay and the Port Lincoln wharves.



At the time, there were several small vessels berthed alongside Brennan Jetty, including the unmanned fishing vessel *Apollo S*, which was berthed starboard side to the phosphate berth.

At 1410, the pilot ordered full ahead on the ship's main engine. With the engine on engine room control, the third mate moved the telegraph to full ahead and this was acknowledged in the engine room. By this time, the ship was just to the south east of Point Boston. Its speed[12] was 8 knots. The tide was flooding, with a high tide of

[12] All speeds referred to in this report are 'made good' or 'over the ground' and have been obtained from the ship's S-VDR.

1.1 m expected at 1422. The wind at the time was recorded in the ship's log book as south to southeast at 11 to 16 knots.

At 1422, *Grand Rodosi* passed the channel entrance beacon to starboard. Its speed was 10.3 knots. At 1431, the ship passed number 4 beacon to starboard, at a speed of 11 knots.

At 1432, the pilot ordered slow ahead. The third mate moved the telegraph to slow ahead and this was acknowledged in the engine room. The ship's speed was 9.7 knots and it was on a heading of 206° (T). It was 1.88 miles from the tanker berth and about 6.6 cables[13] from the tugs, which were waiting to be made fast.

At 1434, the pilot ordered dead slow ahead. The third mate moved the telegraph to the dead slow ahead position and this was acknowledged in the engine room. By 1438, the ship was passing number 6 beacon. The tugs were approaching and its speed had dropped to 8.1 knots.

By 1440, the tugs had been made fast; *Kioloa* on the starboard shoulder and *Wangary* just forward of the break of the accommodation, also on the starboard side. Both tugs were made fast using their lines over the bow. The ship's speed was now 7.2 knots and it was on a heading of 213° (T). The distance to the tanker berth was 7.6 cables.

At 1442, the pilot ordered the main engine stopped. The third mate moved the telegraph to the stop position and this was acknowledged in the engine room. By this time, the ship had slowed to 6.3 knots. It was on a heading of 216° (T) and the distance to the tanker berth ahead was now 4.5 cables.

At 1444, the pilot ordered hard-to-starboard to turn the ship to approach the berth. At 1444½, to assist the turn, he ordered dead slow ahead. The third mate moved the telegraph to dead slow ahead and this was acknowledged in the engine room. The ship was 3.5 cables from the tanker berth and its speed was 5.6 knots.

At about 1446½, the pilot ordered the engine stopped. Again, the third mate moved the telegraph to the stop position and this was acknowledged in the engine room. The ship's heading was 241° (T), its speed was 5 knots and it was 2.9 cables from the tanker berth (Figure 8).

At 1446¾, the pilot ordered slow astern and asked *Wangary* to push to port, at a quarter power. The third mate put the telegraph to slow astern and this was acknowledged in the engine room. The speed was 4.7 knots. At 1447, the pilot ordered midships.

At 1447¼, the pilot ordered half astern. The third mate put the telegraph to half astern and the engine room acknowledged the telegraph order. The pilot then asked *Wangary* to push to port, at half power. At 1447¾, the third mate reported that the ERC telegraph was at half astern. The speed over the ground was now 4.5 knots and the ship was just 2.2 cables off the wharf ahead. However, the ship was not turning to starboard, and its speed was increasing (Figure 9).

[13] One cable equals one tenth of a nautical mile or 185.2 m.

Figure 8: *Grand Rodosi* S-VDR replay at 1446

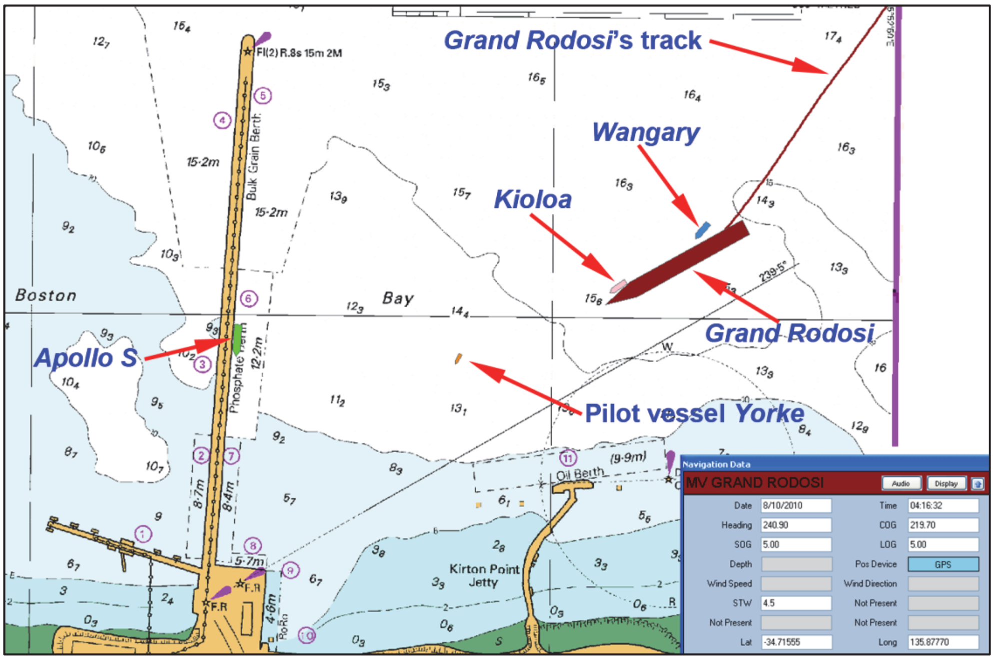
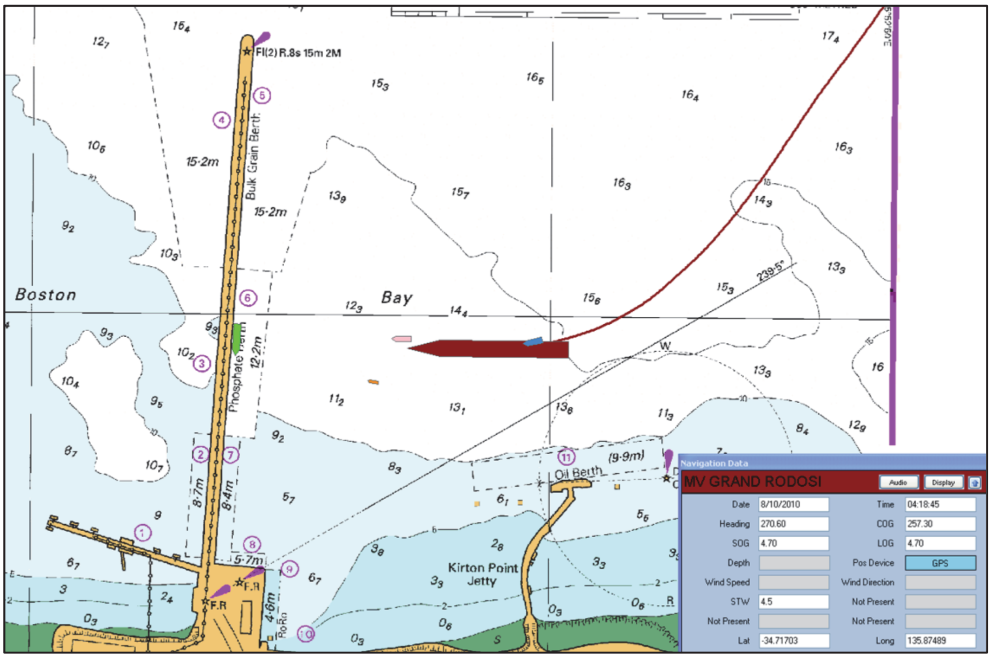


Figure 9: *Grand Rodosi* S-VDR replay at 1448¼



Concerned that the ship was not slowing down or turning to starboard, at 1448¼, the pilot ordered *Wangary* to push at three quarters power. He then immediately ordered full astern. The third mate put the telegraph to full astern and this was acknowledged in the engine room. The pilot then ordered *Kioloa* to standby to 'lift off'. At 1448¾, the third mate reported that the ERC telegraph was at full astern. However, *Grand Rodosi*'s speed was still about 4.5 knots. The pilot then ordered *Kioloa* to lift off at half power.

Then, 1449¼, the pilot ordered *Kioloa* to lift off at full power.

At 1449½, the pilot told *Grand Rodosi*'s master to let go the port anchor. The master instructed the chief mate on the forecastle to let go the port anchor. However, the ship continued to close on *Apollo S* directly ahead of it. The pilot asked the master if the engine was at full astern, to which the master replied 'full, yes'. At about 1449¾, the pilot ordered *Wangary* to push up at full power.

At about 1450, *Grand Rodosi,* at a speed of 4.9 knots, hit *Apollo S* and crushed the fishing vessel against the wharf (Figure 10).

Figure 10: *Grand Rodosi* crushing *Apollo S* against the wharf

At about 1451, while *Grand Rodosi* was embedded in the port side of *Apollo S*, the master of *Wangary* advised the pilot that the ship's engine was going ahead. The pilot immediately shouted at *Grand Rodosi*'s master, saying that the engine was still going ahead. He also indicated that the main engine tachometer was showing that the engine was going ahead, not astern as he had ordered some 5 minutes earlier.

The master immediately rang the engine room, trying to establish what had gone wrong and why the main engine had not run astern.

At 1451¾, the pilot yelled 'stop engine, stop engine, your engine is running ahead' and then to the master 'see here, see here, they're giving wrong power' indicating that the engine tachometer was still showing ahead revolutions. The third mate put the telegraph to stop and the order was acknowledged in the engine room. The pilot then asked *Wangary* to lift off with full power, then to stop and lift off at half power. He then ordered *Kioloa* to lift off at half power and then to stop.

At 1453, the chief engineer went to the engine side control station. He wanted to directly control the main engine from there to make sure that any further engine movements were in the right direction.

At 1453½, the pilot told the third mate to 'give me astern now' and the third mate put the telegraph to dead slow astern and the order was acknowledged in the engine room. The main engine then started and the pilot told the master that the engine was going astern. The pilot then asked *Wangary*'s master if the engine was going astern and the tug master confirmed that it was.

At 1454½, the pilot ordered the engine stopped. The third mate moved the telegraph to the stop position and the order was acknowledged in the engine room. The pilot then ordered *Wangary* to lift off at full power and *Kioloa* to lift off at half power.

Grand Rodosi started to move slowly astern, pulling clear of *Apollo S* and at 1457¼, the pilot asked *Wangary* to stop.

At 1457½, the pilot asked the master if the anchor had been let go. The master relayed the question to the chief mate on the forecastle and was told that the anchor had not been let go because, when told to let go the anchor, the ship was too close to the fishing vessel. The pilot then called the wharf supervisor, via VHF radio, and asked if anybody was on board the fishing vessel. He was advised that no one had been on board.

At about 1500, the master started notifying relevant parties, including the Australian Maritime Safety Authority (AMSA), about the collision. While he was doing this, the pilot continued to back *Grand Rodosi* away from *Apollo S*. When the ship finally pulled clear of the fishing vessel, *Apollo S* rolled onto its port side and began to sink (Figure 11).

Figure 11: *Apollo S* immediately after *Grand Rodosi* had pulled clear

At about 1509, the pilot asked the master why the ship's main engine ran ahead when he had asked for astern. The master told him that he did not know. The pilot then asked the third mate who reiterated that he had put the telegraph astern when ordered to.

By 1530, the pilot had berthed *Grand Rodosi* without any further use of the main engine.

After berthing, an inspection of *Grand Rodosi* revealed that its bow had been dented and holed, both above and below the waterline, in the incident. The ship was detained by AMSA pending class confirmation that its hull, including the underwater area, was watertight.

Following further inspections of the hull and the necessary repairs to class satisfaction, the revision of standing orders for bridge and engine room teams and the fitting of an additional audible wrong way alarm in the engine room control room, AMSA released *Grand Rodosi* from detention at 1200 on 22 October.

On 2 November, Svitzer Salvage Australasia (Svitzer) was awarded the salvage contract for *Apollo S*. On 3 November, Svitzer began to remove the wreck of the fishing vessel and by 7 February 2011, the removal operation was completed.

2 ANALYSIS

2.1 Evidence

On 9 October 2010, two investigators from the Australian Transport Safety Bureau (ATSB) attended *Grand Rodosi* while the ship was berthed at Port Lincoln, South Australia. The master and directly involved crew members were interviewed and each provided their account of the incident. Photographs of the ship and copies of relevant documents were obtained, including log books, navigational charts, statutory certificates, reports, manuals and procedures. Data from the ship's simplified voyage data recorder (S-VDR) was also obtained by the investigators.

On 10 October, the investigators interviewed the pilot who provided his account of the incident.

During the course of the investigation, further information was provided by Flinders Ports, MAN Diesel & Turbo Australia (representatives of the main engine manufacturers), Svitzer Salvage Australasia and the Australian Ship Handling Centre (Port Ash). Information about *Apollo S* was provided by Coates Lawyers, Port Lincoln.

Times used in this report are corrected times from *Grand Rodosi*'s S-VDR and the bridge engine telegraph data logger.

2.1.1 Animated representation of relevant recorded data

An animation of the incident was prepared by the ATSB using Avenca Limited Marine Accident Data Analysis Suite (MADAS) software and is part of this report. A video file containing the animation is available for download from the ATSB website at:
http://www.atsb.gov.au/publications/investigation_reports/2010/mair/279-mo-2010-008.aspx.

2.2 The incident

At about 1450 on 8 October 2010, the partially loaded bulk carrier *Grand Rodosi* hit the moored fishing vessel *Apollo S* when the ship's main engine went ahead and not astern as ordered by the pilot. *Apollo S* was crushed against the wharf and sank when the ship pulled clear. There was nobody on board the fishing vessel at the time.

The collision occurred as the pilot was manoeuvring the ship in a turn following an uneventful passage from the pilot boarding ground. The ship's main engine was in engine room control mode, with the ship's electrical engineer acknowledging the bridge telegraph movements on the engine room control (ERC) telegraph. The chief engineer was controlling the main engine start/fuel lever to action the bridge orders.

The pilot was following his usual passage to the berth for a ship with an after draught of less than 11 m. However, on this occasion, the ship did not complete the planned turn to starboard off the berth, coming out of the turn on a westerly heading, towards the wharf, at a speed of between 4.5 and 5 knots. In order to stop the ship's movement towards the wharf, and *Apollo S*, the pilot ordered a number of successive astern main engine movements and tug orders. However, the ship did not respond as he expected it to and *Grand Rodosi* hit *Apollo S* on its port side.

The replay of the S-VDR shows that it was only when the master of the after tug told the pilot that the ship's engine was going ahead, while the ship was still embedded in the fishing vessel that anyone on board *Grand Rodosi* realised what had happened. Despite the fact that the main engine was not going astern, no one on the ship's bridge or in the engine room control room were aware of the fact.

2.2.1 Testing the main engine after the collision

After the collision, engine trials were carried out while *Grand Rodosi* was alongside its berth in an attempt to recreate the incident. Present at the trial were the ATSB investigators, a representative of the ship's owner, an Australian Maritime Safety Authority (AMSA) surveyor, a Bureau Veritas (BV) surveyor and a representative from MAN Diesel & Turbo Australia.

As the ship was berthed, it was not possible to fully simulate the incident as the ship did not have any forward momentum at the time of testing.

As it was, all attempts to recreate the situation were unsuccessful. At all times, the engine orders were executed correctly and the engine direction of rotation was correctly recorded by the bridge data log printer. In addition, the 'wrong way' lights on both the bridge and ERC telegraph consoles illuminated.

MAN Diesel & Turbo Australia conducted tests and inspections on parts relevant to the manoeuvring system of the main engine. According to the report by MAN Diesel & Turbo Australia:

> No mechanical or pneumatic cause for the wrong rotation could be found during the testing in Port Lincoln.
>
> Testing of the reversing system from the engine control room telegraph showed normal operation. The engine was turned ahead and astern on air and fuel from the engine control room telegraph with normal operation. At no time did the engine start in the wrong direction relative to the engine control room telegraph when in engine control room control.

Importantly, the testing also revealed that the 'main engine emergency stop button' did not function while the engine was in engine room control. This was because a cable plug within the Norcontrol panel in the ECR was disconnected. Consequently, while no attempt was made to use the main engine 'emergency stop' button on 8 October, had an attempt been made, it would have been unsuccessful. This plug was reconnected and the function worked as required.

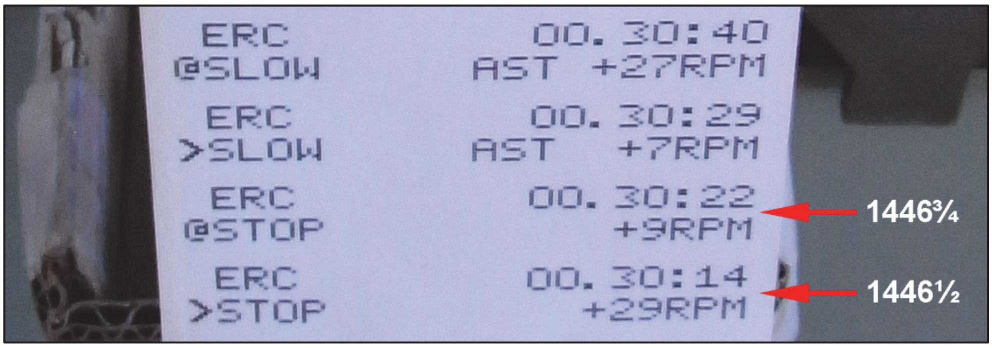
As no mechanical reason for the main engine running ahead instead of astern could be found, the actions of the crew during the approach to the berth on 8 October need to be analysed in detail.

2.3 Wrong way operation of the main engine

During the pilotage on 8 October, following each telegraph order given by the pilot, *Grand Rodosi*'s third mate moved the bridge telegraph to the desired position. Because the ship's main engine was in engine room control, the electrical engineer acknowledged the bridge telegraph command by turning the ERC telegraph to the required engine movement.

At 1446½, when the stop order was given, the main engine was rotating at 29 rpm in the ahead direction (Figure 12). Then, when the slow astern order was given at 1446¾, the engine was rotating at 9 rpm in the ahead direction because the ship was still moving ahead with the water flow through the propeller causing the main engine to 'windmill'.

Figure 12: Data logger printout showing ahead rpm when astern movement requested



To follow the pilot's telegraph orders, the chief engineer, operating the main engine start/fuel lever, brought the lever to the stop position when the ERC telegraph was put to stop. However, when the ERC telegraph was then quickly put to slow astern, he moved the lever to the start position, and then out of the start position to the run position. Because the main engine was still rotating in the ahead direction, when he moved the start/fuel lever, he did not allow enough time for the braking air to stop the engine rotating ahead and then turn it in the astern direction. As a result, because the engine was still turning ahead, when fuel was admitted to the engine, the engine ran in the ahead direction, despite the astern positioning of the ERC telegraph and the fuel cams.

When asked during interview whether he looked at the main engine analogue tachometer to check on the direction of rotation, the chief engineer said that he was concentrating on the speed of the telegraph orders and was looking at the ERC telegraph, the lever position and the digital rpm counter on the Norcontrol panel on the engine room console, a counter which did not show direction of engine rotation. At no time did he look at either the analogue tachometer, which clearly displayed rpm in the ahead or astern direction or the fuel cam indicators on the main engine indicator panel, which were just below and to the right of the analogue tachometer. Consequently, he was not aware that the engine was rotating in the ahead direction instead of the astern direction.

In addition, despite two functioning, flashing red 'wrong way' lights on the ERC telegraph console, neither the chief engineer nor the electrical engineer saw that the lights were lit, indicating that the main engine was running the wrong way.

Consequently, when the pilot ordered increased astern power from the main engine, although the ERC telegraph was moved to the correct astern position, the chief engineer continued to put more fuel into the engine, without checking the direction of engine rotation, and the engine's rpm ahead increased.

2.4 Defences to prevent wrong way running

2.4.1 System defences

There were three methods of main engine control on board *Grand Rodosi*: bridge control; engine room control and engine side control.

Bridge control was remote through the Norcontrol AutoChief III system. In this mode, the engine was controlled directly from the bridge telegraph and the system was designed to automatically stop and start the main engine with the appropriate interlocking to prevent 'wrong way' operation. Consequently, defences were built into the system's operating logic to provide braking air and to block fuel admission to the engine if the direction of rotation and the telegraph position did not correspond, thus preventing 'wrong way' rotation of the engine.

In this mode of operation, the AutoChief system also had an audible 'wrong way' alarm to alert the ship's crew if, for any reason, the engine started in the wrong direction.

However, on 8 October 2010, *Grand Rodosi* was operating in engine room control, a fundamentally manual operation where the engineer must decide when braking air is to be admitted, if the direction of rotation is correct and when fuel should be admitted to the engine. If the telegraph and direction of engine rotation do not correspond, fuel can still be admitted to the engine and the engine can be run in the opposite direction to that desired.

Without automated interlocks to prevent it, the crew, both in the engine control room and on the ship's bridge, needed to be acutely aware that they formed the only defence against 'wrong way' operation of the main engine. With no audible alarm, they needed to be actively monitoring the visual main engine movement indicators in the control room and on the bridge in order to rapidly detect any differences between the telegraphed engine order and the actual engine movement. This was especially important during any pilotage, and when the ship was manoeuvring in a close quarters situation, when the risks were much greater.

On 8 October 2010, they were not monitoring the engine movement indicators.

2.4.2 Procedural defences

When the decision was made not to use the AutoChief III bridge control system, the ship's operators should have undertaken some form of assessment to identify and mitigate the risks associated with the decision. One of the biggest risks was that associated with an inadvertent 'wrong way' operation of the main engine and the consequent need to ensure that the crew were informed of this risk and therefore appropriately vigilant.

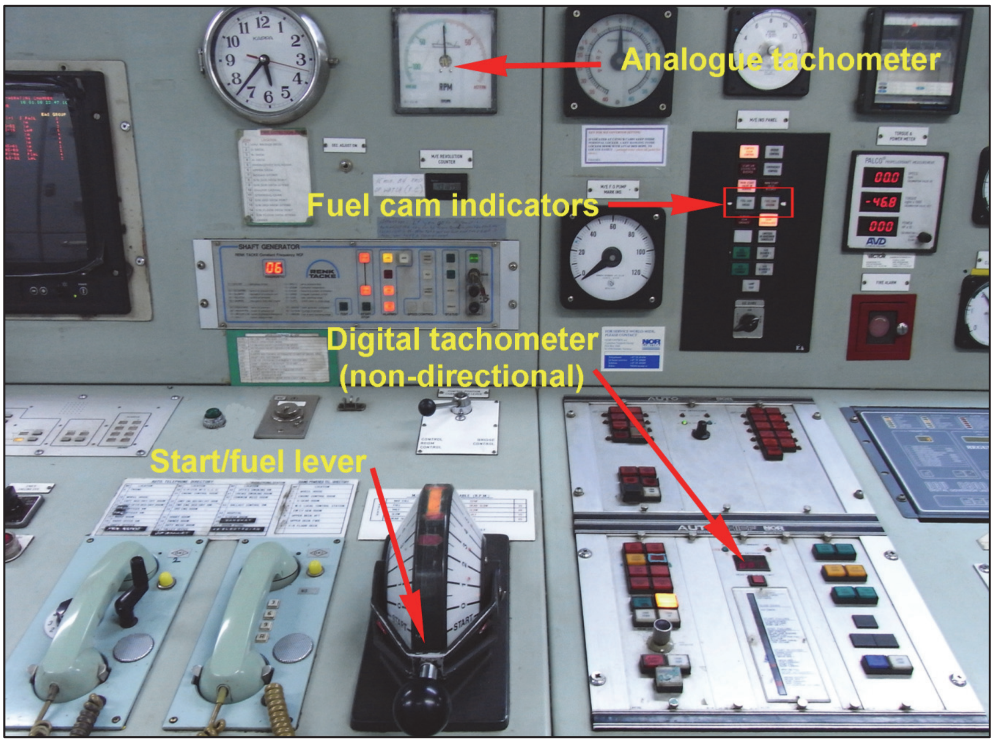
To help the crew to be at their most vigilant, some form of guidance and/or instructions should have been provided in the ship's safety management system; however, at the time of the collision there was no such guidance and/or instructions.

2.4.3 Human defences

Use of main engine tachometers

Good seamanship communication practice dictates 'closing the loop'. After any order has been given, whether engine or helm, the person giving the initial order and the person carrying out that order need to check that the required outcome is achieved (i.e. the engine turns in the desired direction or that the rudder moves in the desired direction).

Figure 13: Main engine tachometer mounted on the engine console



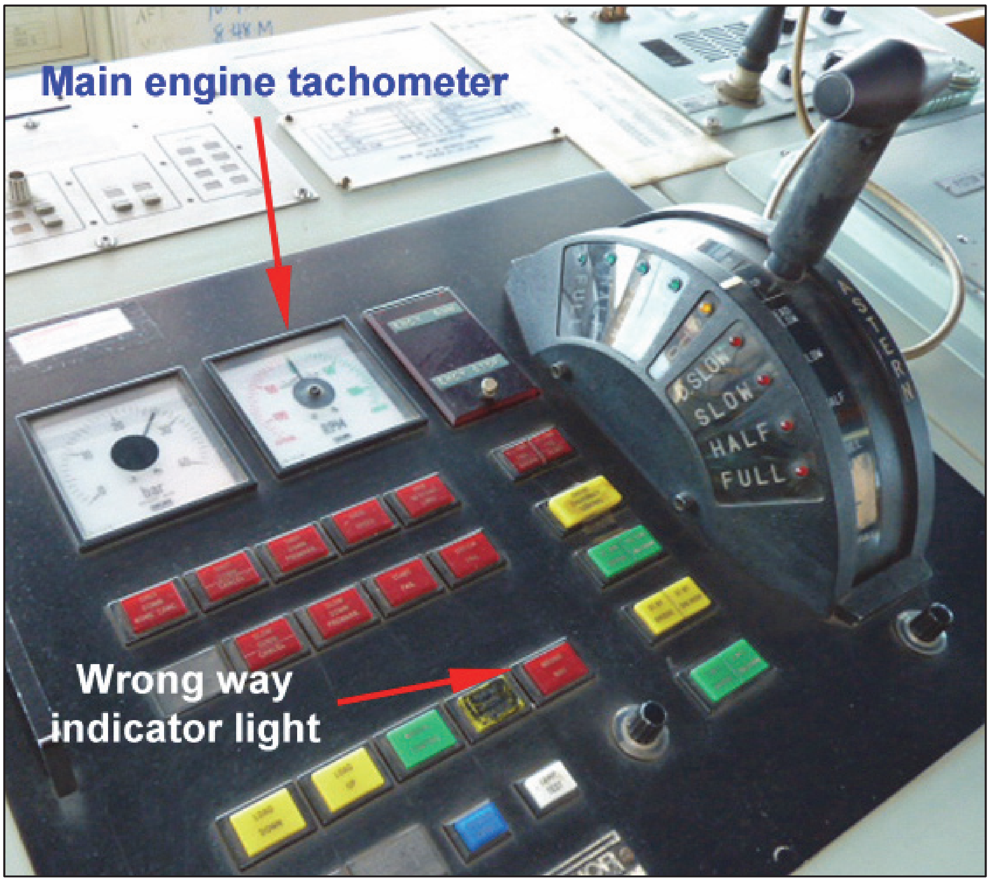
At no time from when the initial astern movement order was given at 1446¾ to about 1451, when it was observed that the ship's main engine was still operating ahead, did *Grand Rodosi*'s chief engineer look at the analogue tachometer located directly above the start/fuel lever and directly forward of where he was standing at the console (Figure 13) to see which way the main engine was rotating. As he stated in his interview, his attention was diverted by the quick telegraph orders, and by looking at the ERC telegraph and the digital tachometer.

However, there were two other engineers at the console at the time and neither of them looked at the analogue tachometer at any time. These men, along with the chief engineer, should have been making sure that the engine was turning in the right direction.

In addition, while the main engine continued to run ahead, no one in the engine room control room saw the flashing 'wrong way' lights on the ECR telegraph. These cues would have been highly visible and 'out of the ordinary' and should have been readily apparent to any engineer who had served on *Grand Rodosi* for any period of time while the ship was being manoeuvred in manual control.

Regardless of the inaction of the engine room staff, neither the pilot, the ship's master nor the third mate looked at the main engine tachometers located, and clearly visible, on the bridge at any time from when the initial astern order was given, throughout the following sequence of astern orders, until the after tug master advised the pilot that the ship's engine was running ahead.

Figure 14: Main engine tachometer mounted on the engine console



After moving the bridge telegraph to any of the astern positions, the third mate should not only have checked that the ERC telegraph matched the bridge telegraph orders, but that the direction of engine rotation also corresponded to the orders. This was a simple task – looking at the engine tachometer located immediately next to the bridge telegraph (Figure 14) or the tachometer mounted on the bridge front (Figure 15), immediately in front of him. In addition, the third mate's level of attention during the pilotage should have been such that the red flashing 'wrong way' light on the bridge telegraph console should have alerted him to the fact that something was not right; and therefore prompted him to take further action to see what the flashing light meant.

Figure 15: Main engine tachometer mounted on the bridge front

Had the third mate done so, he could have alerted the pilot and the master to the fact that the engine was still turning in the ahead direction at about 1447, just after the first astern order and in time for corrective action to be taken to ensure that the engine did turn as desired.

In addition, both the master and pilot should have looked at the tachometer after each engine order. Had they simply glanced once at the tachometer, it would have been apparent to them that things were not as they should have been at 1447, and corrective action could have been taken. As it was, they remained standing on the port side of the bridge front, expecting that the orders for increased astern power, and the requested assistance of the tugs, would stop the ship's unrelenting progress towards the fishing vessel at the berth ahead.

Other clues to incorrect direction of rotation

Grand Rodosi's main engine should have been running astern, and not ahead, for about 4 minutes before the collision with *Apollo S,* including almost 2 minutes at full astern. Despite this relatively lengthy time at full astern, no one was alerted to the fact that something 'wasn't right' when there was no vibration of the ship as would normally be expected when a ship is running at full astern in shallow water.

Replay of the ship's S-VDR clearly shows that there is no excessive vibration noise at any time leading up to the collision. The bridge is relatively quiet, except for the increasing concern in the pilot's voice as the ship closed on *Apollo S*.

Not only was the absence of vibration at full astern missed but no one on the bridge appears to have looked at a radar or GPS display, where the ship's speed would have been readily apparent.

2.5 Main engine operation manual guidance

As *Grand Rodosi* closed on *Apollo S*, the pilot's actions, with regard to the increasing astern orders, amounted to ordering a 'crash-stop' on the ship's main engine, as defined in the ship's main engine operation manual.

The following guidance is provided in the manual, under the starting, manoeuvring and running section, with regard to 'crash-stop' operations in manual control:

> 4. CRASH-STOP
>
> This is a reversing of the engine when the ship's speed is high.
>
> Even when the engine has received a stop order, it will continue to rotate (at slowly decreasing r/min) because the velocity of the ship through the water, will drive the propeller, and thereby turn the engine.
>
> Acknowledge the telegraph and give STOP order to the engine. Before giving the starting order, wait until the engine revolutions have fallen to "REVERSING LEVEL" (20-40% of MCR r/min, depending on engine size, and type of ship).
>
> Give the start order and allow starting air to the engine, until it has been braked, and has come up again to sufficiently high revolutions in the desired direction. Then give order to run on oil. Check that the direction of rotation is correct.
>
> Owing to "conflict" between the wake, and the propeller, heavy hull vibrations may occur, therefore, the engine speed should be kept low during the first few minutes after start.
>
> If the ship's speed is too high when the crash-stop is attempted, to not lose starting air by allowing the starting attempt to last too long. Give the engine a new STOP order, and wait until the revolutions have fallen still further, before making a new start.

These instructions clearly stated that air should be admitted to the engine until it has been braked and has started turning on air in the desired direction, before allowing fuel into the engine. Importantly, the guidance includes checking the direction of rotation is as ordered.

The chief engineer had been on board *Grand Rodosi* for 3 months before the collision. In that time, being aware that the AutoChief bridge control system was not being used on the ship, he should have familiarised himself with the guidance provided in the main engine operation manual so that he had a thorough knowledge of all the issues dealing with situations which might arise during his time operating the start/fuel lever, and general engine room operations during manoeuvring for which he was responsible.

2.6 The berthing manoeuvre attempted on 8 October

Turning a ship off a wharf, with two tugs made fast, is a common ship handling manoeuvre. However, when the manoeuvre involves turning a ship so that its bow swings towards the wharf, it becomes probably the most critical of turns because the risk of the ship 'tee-boning' the wharf or another vessel is raised and therefore, the manoeuvre has the most potential for damage.

The ATSB has investigated two incidents[14] involving a similar manoeuvre in the past where the outcomes resulted in significant damage to the wharf and/or ship; *Amarantos* in Wallaroo[15], South Australia, on 10 April 2000; and *SA Fortius* at Port Kembla, New South Wales, on 15 April 2002. Both these ships had a pilot on board at the time of the collision.

Advice received from the Australian Ship Handling Centre (Port Ash) is that as the risk of 'tee-boning' is high, the manoeuvre should be carried out slowly and with the utmost caution to allow for the possibility of human or mechanical error.

According to the Port Lincoln pilot, this type of turn was his usual manoeuvre for a ship with a draught of less than 11.0 m, as was his approach to the turn following a transit of Boston Bay. Since gaining his licence for the port, he had piloted 25 inbound ships to the berth, a large proportion of which would have had a draught of less than 11.0 m. He handled those ships in a similar way to his plan for *Grand Rodosi*, with the exception that the starboard turn for each of the other ships was successful.

2.6.1 Transverse thrust and speed

Grand Rodosi arrived at Port Lincoln after a voyage from Brisbane. The ship was partially loaded and was to 'top off' in the port. Consequently, with the ship heavily trimmed by the stern (4.7 m), it would handle differently to a ship of the same size on a near even keel. The pilot and master should have been aware of that fact during any ship handling undertaken during the passage.

As the ship made its way through Boston Bay, outside the channel, the maximum speed it attained was 11 knots (full ahead). At 1432, the pilot ordered slow ahead and the speed dropped to just below 10 knots. Two minutes later, in preparation for making the two tugs fast, he ordered dead slow ahead and as the ship passed number 6 beacon, its speed was still 8.1 knots.

The ship's speed was falling and the main engine was at dead slow ahead for making the tugs fast, both in accordance with the guidance provided in the Flinders Ports marine operations guidance document for Port Lincoln pilotages (Section 4.1.15 - *Berthing at No. 5 Head out*).

At 1440, while *Grand Rodosi*'s engine was at dead slow ahead, its speed was about 7.5 knots when the tugs were made fast. However, while dead slow ahead is specified in these directions, no actual speed is mentioned for making the tugs fast.

The ship's speed/rpm data indicates that dead slow ahead revolutions (30 rpm) will give the ship a speed between 5.2 and 5.7 knots, depending on its loaded condition. On 8 October, the ship had not been on dead slow ahead long enough to achieve this speed and, as a result, was still making almost 2 knots more over the ground.

When the pilot commenced the turn to starboard at 1444, the ship's speed had decreased to 5.6 knots. By that stage, the ship was abeam its berth, about 3 cables off, and the speed entering the turn was, for a partially loaded bulk carrier, probably higher than it should have been[16].

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14 ATSB safety investigation reports numbered 157 and 178 (www.atsb.gov.au).

15 Wallaroo is a port operated by Flinders Ports.

16 Advice received from Port Ash.

At 1446½, the pilot ordered the main engine to be stopped and then shortly afterwards, to be put astern. His intention was to use the transverse thrust of the ship to help move the ship's stern to port and help swing the ship's bow to starboard. However, the propeller continued to rotate in the ahead direction with the forward momentum of the ship. From then on, as discussed earlier, despite the succession of astern orders, the engine continued to turn ahead.

With regard to any influence of the transverse thrust of the ahead running engine on the manoeuvre, the Nautical Institute's *Shiphandler's Guide*[17] states:

> The net result is a tendency for a right-handed propeller to give a small swing to port when running ahead. Whilst this may be noticeable in calm and near perfect conditions it is easily influenced by other likely factors such as wind, current, shallow water, tugs, rudder errors and so on.

Given this information, it is unlikely that the running ahead of *Grand Rodosi*'s engine had any major influence on the ship's turn. However, it may have had an effect on the effectiveness of the two conventional tugs' ability to help the turn the ship to starboard.

When it comes to speed, higher speeds during ship manoeuvring result in a reduction in the time available to take corrective action if a mistake is made or a malfunction encountered during the manoeuvre.

With regard to *Grand Rodosi*, its speed entering the turn was still probably higher than it should have been for a partially loaded ship. This would possibly not have resulted in adverse consequences if everything had gone according to the pilot's plan. However, when the engine did not go astern, and that this fact was not identified by those on the bridge at the time, the pilot lost control of the manoeuvre and did not have the time or resources to allow a recovery.

It is evident that the pilot continued to put his faith in the manoeuvre he was attempting and while he tried to prevent the collision at the very last minute by ordering the anchor let go and the tugs to try and assist with slowing the ship, it was too little too late.

2.7 Identified risks during pilotage in Port Lincoln

The manoeuvre *Grand Rodosi*'s pilot was attempting to execute on the day of the collision was described in the Flinders Ports marine operations guidance document for Port Lincoln pilotages (Section 4.1.15 - Berthing at No. 5 Head out). In their risk register, Flinders Ports had identified a number of risks/hazards relevant to Port Lincoln pilotages. These included: vessel proceeding too fast; engine failure; non-attendance of tugs; and collision with other commercial vessels at anchor or underway. With the exception of the non attendance of tugs, these inherent risks were deemed as being extreme (the tug risk was deemed as being high) and risk control measures were put in place to help manage those risks.

The control measures for a vessel proceeding too fast or too slow included BRM procedures, the master/pilot information exchange, ship characteristics, the use of portable pilot units[18], and pilot training.

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[17] The Nautical Institute. *The Shiphandler's Guide*. London. Second edition 2007, p23.

With regard to a possible engine failure during the pilotage, the risk control measures were: the provision of tugs when available, pilots adequately trained in emergency procedures via simulator training and contingency plans, both anchors cleared away ready for immediate use and testing engines prior to pilot boarding.

The risk of a ship colliding with a wharf or another ship on an adjacent berth, while this manoeuvre was being attempted, was not in the risk register.

This was a foreseeable risk for the manoeuvre *Grand Rodosi*'s pilot was undertaking as it had happened in another Flinders Ports managed port in the past (*Amarantos* in Wallaroo). During the manoeuvre being attempted in Port Lincoln, there was the risk of the ship approaching the turn too fast and hence the manoeuvre not going to plan because the tugs could not have the desired effect to help the ship turn. There was also the risk of the ship's engine/s not functioning as desired, thus resulting in the turn not going as planned. A risk external to the ship was associated with the tugs themselves and any problem they encountered during the manoeuvre could result in the manoeuvre not going as planned. However, without a risk assessment being made by Flinders Ports on this particular manoeuvre, appropriate risk controls and contingencies were not and could not be implemented to reduce the risk.

In their initial submission to the investigation, Flinders Ports stated that:

> The risk assessment [for Port Lincoln] is a comprehensive risk assessment and the issue of a vessel's engines going ahead when an astern movement is rung on the telegraph was not envisaged. Collision and various scenarios relating to collisions with another vessel or the wharf has been covered adequately and is reflected in the risk assessment documents sent to the ATSB.

While the issue of a ship's engine going ahead when an astern movement is rung may not have been envisaged, the result is similar to an engine failure or an engine failing to go astern. Situational awareness is crucial for any risk control to be effective particularly when the ship's speed approaching the wharf allows very little time to implement any contingency plan. In this case no one was aware that the main engine was running ahead for the critical three and a half minutes before the collision.

The Flinders Ports marine operations guidance document for Port Lincoln pilotages is the operational document for pilotages within the port. While the document contained general directions about when to commence the starboard turn towards the Port Lincoln wharf, no mention was made within the document of what speed a ship should be making good at critical positions, such as when making the tugs fast or commencing the turn. The issue of speed during pilotages should form an important part of any port risk assessment and associated control measure therefore, the Port Lincoln marine operations guidance document was lacking in this important facet of risk management.

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[18] A portable, computer-based system that a pilot brings on board a ship to use as a decision-support tool for navigating during the pilotage. Interfaced to a positioning sensor such as GPS/DGPS and using some form of electronic chart display, it shows the ship's position/movement in real-time.

2.7.1 Contingency planning

Neither Flinders Ports nor the pilot had developed any plan to deal with the passage to the berth, or the particular higher-risk manoeuvre being undertaken by the pilot, not going as planned. As a result, no contingency plan was discussed during the master/pilot information exchange.

The pilot did not identify an abort position; a position in the passage where, if everything was not going as planned (such as the ship's speed being too high), he could safely abort the manoeuvre and 'start again'. He did not, at any time, try anything other than getting the tugs to turn the ship as it approached *Apollo S* (as discussed in section 2.8). There is no evidence that the option of putting the helm hard-to-starboard and 'kicking' the main engine to full ahead to turn the ship more quickly to starboard was considered.

Neither did he order the main engine stopped and then put astern again. This is probably because he did not realise at the time that the ship was not responding. Had he done this, it is probable that the chief engineer might then have realised his mistake, and rectified it. This action may not have stopped the ship but it may have reduced its forward speed to a point where the tugs may have become more effective and the damage to *Apollo S* might not have been so severe.

In June 2010, *Grand Rodosi*'s pilot had undertaken ship handling simulator training, in both a computerised bridge simulator and using practical manned models. The bridge simulator training had been for the ports of Adelaide and Thevenard and had not covered the type of higher-risk manoeuvre he usually performed for ships arriving in Port Lincoln with draughts less than 11.0 m.

However, while he had not had the chance to develop any specific contingencies for this manoeuvre in Port Lincoln, the ship handling knowledge obtained during his 5 years as a pilot, both in Singapore and in South Australia, combined with simulator training and practice in the manned models, should have enabled him to develop contingencies for managing the risks of this manoeuvre when he began undertaking it.

2.8 Use of tugs

2.8.1 Positioning of the tugs

The two tugs attending *Grand Rodosi* were both conventional tugs and they were made fast using bow lines. The forward tug was made fast on the ship's starboard shoulder and the after tug was made fast at the break of the accommodation, starboard side. The positioning of the tugs was such that they could assist the ship to make a starboard turn and then, once the turn was completed, push the ship alongside the wharf. All this could be done without having to reposition the tugs at any time during the manoeuvre.

This was the usual way and location for the tugs to be made fast and was included in the Flinders Ports marine operations guidance document for Port Lincoln pilotages (Section 4.1.15 - Berthing at No. 5 Head out).

The positioning of tugs is discussed in the Nautical Institute publication *Tug use in port – a practical guide*[19]. With regard to the positions that the two tugs were made fast to *Grand Rodosi*, the following comments made in this publication are relevant for a ship making a turn to starboard:

> [The forward tug] can assist the starboard turn by going astern. In doing so, an additional starboard turning couple is created by the tug's and ship's engines working in opposite directions. By going astern the tug is slowing down ship's speed, and thus increasing the effect of the Ship's engine on the rudder. The tug's underwater resistance contributes to the starboard swing
>
> [The after tug] is in an effective position to assist the starboard turn by pushing, because of the long lever and forward centred lateral resistance, which contribute to the swing. The tug's underwater resistance gives additional turning effect to starboard. When [the] tug cannot work at right angles, ship's speed increases, but as a result of the higher rate of turn caused by the pushing tug and consequently the higher drift angle, ship's speed is hardly affected.

With the above in mind, the positioning of the two tugs was correct to assist the ship to turn to starboard. However, the effectiveness of the tugs in these positions is dependent on the type of tugs being used. Furthermore, because the ship’s speed in the turn was possibly higher than it should have been, their effectiveness was reduced, and in the case of the forward tug, almost to the point where it was ineffective.

2.8.2 Tug effectiveness at ‘high’ speed

According to the *Tug use in port – a practical guide*[20]:

> The pushing effectiveness of conventional tugs decreases quickly with increasing ship’s speed; pulling is only possible at zero or low speeds, depending on whether a stern line is used. Ship’s speed should be carefully controlled so as to take account of the limited capabilities of a conventional tug operating at a ship’s side.

By 1440, with *Grand Rodosi* at dead slow ahead, the tugs had been made fast just as the ship passed number 6 beacon, again following the guidance in the marine operations document for Port Lincoln pilotages. By this time, the ship’s speed was 7.2 knots. A short time later, the pilot started the turn to starboard and the speed was 5.6 knots.

As the turn progressed and then stopped, with the ship heading directly for *Apollo S*, the pilot tried to gain more assistance from the tugs to both stop the ship’s forward movement and to get it turning again by requesting the after tug to push up at full power and the forward tug to pull off at full power.

However, while he was attempting this, the speed of the ship did not fall below 4.5 knots, and actually increased a little as the ship came out of the turn. Consequently, the effectiveness of the tugs to provide the assistance that the pilot wanted was dramatically reduced.

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19 Second edition, 2003, pages 62 to 64.

20 Page 57.

The forward tug's effectiveness

When a ship is moving ahead, its pivot point[21] sits about one quarter to one third of the ship's length from the ship's bow. Consequently, the effectiveness of a tug to turn a ship by pushing or pulling forward is reduced because the turning lever at that position is very small.

On 8 October 2010, with the forward tug made fast at the forward end of the ship's number 1 hatch cover, the pilot's command to 'lift off' at any power meant that the tug was unable to influence the ship forward motion and pull the bow around to starboard.

However, had the pilot requested the forward tug to 'lay back alongside and pull', it would have had some braking effect on the ship, especially when at a speed of more than 3 knots, and this might have been more influential on the ship's forward motion.

The after tug

The pilot's first reaction to get the ship to turn to starboard as it approached *Apollo S* was to have the after tug 'square up' and push with increasing power. This was an attempt to push the stern to port and therefore help turn the ship's head more to starboard.

The distance the after tug was from the ship's pivot point meant that this tug had the best chance to influence the turn of the ship.

However, with the ship still moving ahead at 3 knots or better, conventional tugs are limited in their ability to provide turning action when pushing up[22]. As the ship's speed increases, it becomes increasingly difficult for a conventional tug, because of its limited steering capability, to stay at right angles to the ship ('square up'), the most effective pushing direction.

Tug use in port – a practical guide discussed simulation studies[23] undertaken on the capabilities of conventional tugs when pushing[24]:

> As indicated in the graph (Figure 16), the pushing angle becomes smaller as soon as the ship gathers speed. The transverse pushing forces exerted by this tug decrease with ship's speed higher than five knots, but longitudinal forces increase very quickly at speeds above four knots. These longitudinal forces increase ship speed.
>
> According to the same study, the effectiveness of conventional tugs with inferior rudder performance decreases quickly at ship speeds of about four knots.
>
> In practice, a speed of five or even four knots is a rather high limit for conventional tugs to exert transverse forces effectively. The study results may be affected because not all factors influencing tug performance could be taken into

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21 The itinerant vertical axis about which a ship rotates during a turn.

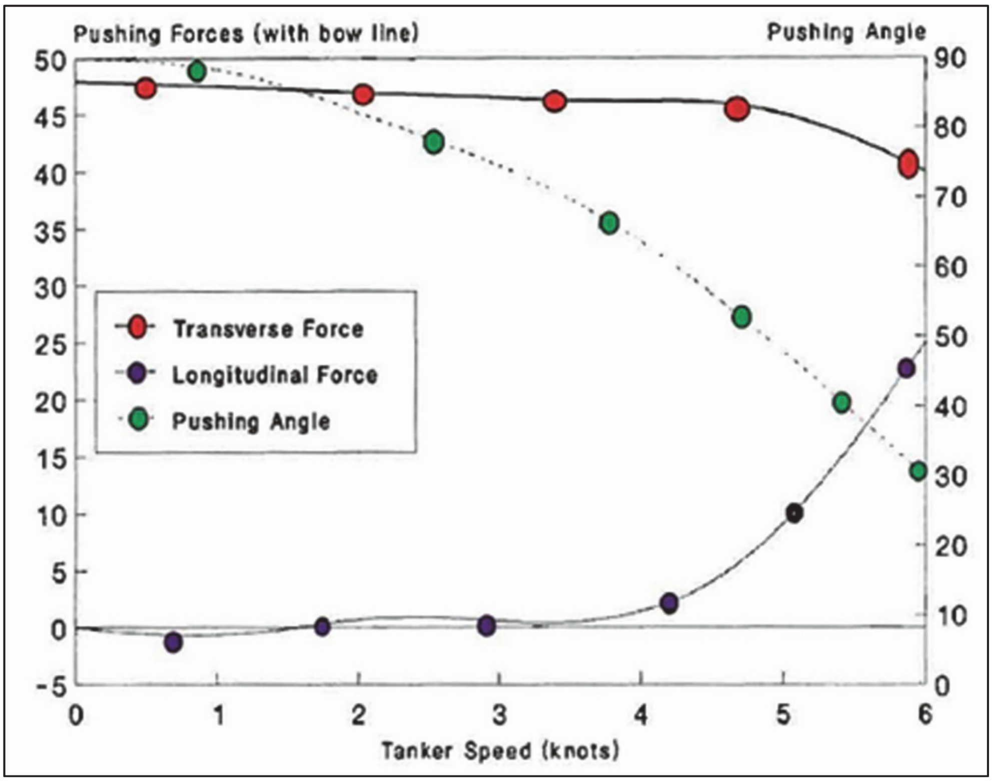
22 Advice received from Port Ash is that while 4.5 knots is quoted in texts, the actual speed is about 3 knots.

23 A twin screw, 40 m long conventional tug with a bollard pull on 50 tonnes, slightly larger than the Port Lincoln tugs.

24 Pages 57 and 58.

account. Naturally, differences in performance exist between various types of conventional tugs. In general, however, the upper limit at which effective sideways pushing forces can be exerted is found to be about three knots.

Figure 16: Performance and behaviour of a 40 m conventional tug



The section in the publication concludes by stating that:

> At ship speeds higher than around four knots, and for less manoeuvrable tugs three knots, the performance of conventional tugs is very poor. At these higher speeds transverse pushing forces are minimal, but longitudinal forces increase very quickly, thus increasing ship's speed, which is not desirable.

Advice from Port Ash agrees with the statements from this publication in that:

> It is physically impossible for a conventional tug fast alongside to 'lift off' with ship's headway of 4.5 knots. It can 'lay back' to reduce headway but the half-beam turning effect on a large ship is minimal. It is commonly observed during training exercises that some pilots expect azimuth stern drive[25] performance from a conventional tug...

Therefore, it is probable that not only was the effectiveness of the after tug to turn *Grand Rodosi* reduced because the ship's speed was about 5 knots, there were forces from the tug's motion acting on the ship which actually contributed to its speed ahead.

At no time did the pilot attempt to use the after tug as a braking force, asking it to 'lay back alongside and pull'. Had he done so, combined with the forward tug doing

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25 A multi-purpose tug, with azimuthing propellers aft, which enables the vessel to operate a towline over its bow like a reverse-tractor tug, as well as over the stern like a conventional tug, thereby combining the advantages of both types of tug.

something similar, he may have been able to reduce the ship's headway and possibly turn the ship to starboard and thereby limit the impact with *Apollo S* to some degree.

2.9 Bridge resource management (BRM) during the pilotage

Bridge resource management can be defined as the effective management and utilisation of all resources, human and technical, available to the bridge team to ensure the safe completion of the vessel's voyage[26].

BRM provides a method of organising the best use of these resources to reduce the level of operational risk. Its key safety aspect is to put in place defences against 'single-person errors', which can result in a serious casualty.

These BRM principles include closed loop communications, briefing/debriefing, challenge and response, delegation, situational awareness, and short-term strategies.

The implementation of these principles on any ship's bridge is the responsibility of all bridge team members, and includes the pilot. However, it should also be recognised that a pilot is more than just a member of a bridge team. The pilot, along with the ship's master, is a 'joint-manager' of the bridge team and should therefore work with the master to provide the necessary level of leadership required to ensure that the bridge team functions as one unit. As with all managerial roles, this requires some oversight of the team to ensure tasks are being carried out correctly.

One of the main principles of BRM is the concept of a shared mental model. A shared mental model helps explain one aspect of how teams, regardless of the environment in which they operate, are able to cope with difficult and changing task conditions. Shared mental models serve three critical purposes: they help people to describe, explain and predict events in their environment. Any team that must adapt quickly to changing tasks might draw on shared or common mental models for those tasks. In order to adapt effectively, team members must be able to predict what their team mates are going to do, and what they are going to need to be able to do it[27].

A shipboard operational environment is a 'slow system' by comparison to the 'fast-moving' aviation environment or some emergency response operational environments. It seldom places excessive time pressures on ships' crews and is more predictive and less reactive. Therefore, the importance of teams in the maritime environment having a shared mental model of operations should not be underestimated and communications between team members should not become an issue.

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26 *Focus on Bridge Resource Management.* Washington State Department of Ecology, 2009.

27 Cannon-Bowers, JA, Salas, E, Converse, S A (1993). *Shared mental models in expert team decision making*. In Mathieu, J, Heffner, T, Goodwin, G, Salas, E, Cannon-Bowers, J. *The influence of Shared Mental Models on Team Process and Performance*. Journal of Applied Psychology 2000, Vol 85, No. 2, pp. 273-283. American Psychological Association Inc, 2000.

2.9.1 Master/pilot information exchange

The first and best opportunity to develop a shared mental model between bridge team members for a ship under pilotage is an effective master/pilot information exchange. If insufficient information is passed between the pilot and the ship's master, the shared mental model may be deficient and bridge team members may not have all the necessary tools and information available to them to ensure a safe pilotage passage.

During the information exchange on board *Grand Rodosi*, the pilot informed the master that the ship would not be using the shipping channel that day and that it would be proceeding outside the channel and heading towards the tanker berth (at Kirton Point), before being turned to approach the berth. He advised the master about positioning the two tugs and that the ship would 'turn around' and use the pilot boat to run the first lines ashore. He also asked if the ship's main engine had been tested before he had boarded, the condition of the anchors, that the bridge team should plot positions on the chart and challenge him 'if he was going the wrong way' (with reference to the route he was taking the ship).

With regard to the actual passage to the berth, there was no discussion about waypoints, actual courses that the pilot would follow during the passage, speed limits or speeds at certain times during the passage, when he would start the turn and the speeds entering the turn and during the turn or any effect the tide might have on the ship during the turn.

These were important issues to cover during the master/pilot information exchange and were required to be covered by a Port Lincoln pilot under the Flinders Ports marine operations guidance document for Port Lincoln pilotages. Failure to do so prevented a proper shared mental model from being established amongst the members of the bridge team.

As a result of not having a proper shared mental model, no one on *Grand Rodosi*'s bridge team knew what speed the ship should be doing at critical points during the passage, such as when the tugs were to be made fast, at the beginning of the turn or during the turn. If they had, they could have brought it to the pilot's attention if the ship's speed was faster than it should have been at those critical points.

Furthermore, during the information exchange, the master did not tell the pilot that the ship was manoeuvring in engine room control. If he had done so, the pilot may have requested that any telegraph command be confirmed as being carried out correctly and may himself have been more vigilant in his observation of engine movements during the pilotage.

2.9.2 The pilotage passage plan

The importance of having a passage plan for pilotage is critical for effective BRM. At one end of the scale, when there is no passage plan, there can be no shared mental model, no challenge and response opportunities, no real knowledge and understanding of roles and responsibilities of the bridge team members and no limits against which the passage can be assessed. If only a basic passage plan exists, then only a basic level of BRM principles can be possible.

Current 'best practice' passage planning includes the effective use of BRM principles, berth-to-berth passage planning, contingency planning, and enhanced master/pilot information exchanges. It also includes engaging a pilot as a member of a bridge team, the efficient use of electronic navigation aids during a passage and the designation of bridge team members to carry out roles with defined responsibilities during a pilotage.

When the pilot boarded *Grand Rodosi* on 8 October, he presented the ship's master with a standard passage plan for the port[28] (Appendix A). The plan was a generic one and did not have any specific passage information on it for the ship's passage to the berth that day, specifically any course or speed information.

During the information exchange, when the pilot was told the ship's arrival draughts, he told the master that the ship would not need to proceed down the port's main shipping channel as there was enough water under keel to proceed through the bay to the east of the channel.

According to the Flinders Ports marine operations guidance document for Port Lincoln pilotages (Section 4.1.15 - Berthing at No. 5 Head out), this is the most common passage to number 5 berth for arriving ships with appropriate draughts. While this was the case, speed was not mentioned in the operations guidance document so the document was not able to provide any useful guidance in this regard.

This was the first time the crew of *Grand Rodosi* had visited Port Lincoln so they had no prior knowledge of port procedures to fall back on. The ship had not received any advice in advance of the pilot's boarding informing the crew of the most likely pilotage passage for non-laden ships. Consequently, the ship's prepared arrival passage plan from the anchorage to the berth had been put together believing that the ship would be transiting the channel. This meant that the crew were prepared for one passage and when told by the pilot that a totally different passage was to be undertaken, they needed to quickly change their thoughts to accommodate the new plan.

Not only were the crew not prepared for the passage outside the channel, the information that the pilot gave the bridge team during the information exchange did not provide sufficient information on some important issues which the bridge team needed. Therefore, the courses drawn on the ship's navigational chart for the passage were not changed and they were not able to properly keep track of the ship's progress, either actual or anticipated, during the transit through Boston Bay to the berth.

As a result of not having any waypoints and charted courses to follow, and no knowledge of what speed the ship should be doing at critical points during the passage, the bridge team were unable to know what the pilot's intentions were in advance. As a result, they had no shared mental model to follow and no defined limits with which to gauge the progress of the ship as it progressed through Boston Bay, outside the channel. Consequently, they had nothing to 'challenge' the pilot about as they did not have a proper understanding of the courses which the pilot would be following.

With the passage plan as it was, there were no defences against a single person error in place during the passage to the berth because none of the bridge team knew when to alert the pilot if any limits were being reached or if any error was being made.

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[28] Available online as a downloadable document from the Flinders Ports website.

Complete pilotage passage plans

Presenting the master of an inbound ship with a 'blank' passage plan does not follow pilotage best practice currently being employed by a number of pilot organisations in Australia. As it stands, the current Flinders Ports pilotage passage plan for Port Lincoln really only provides general information.

In Port Lincoln, there are two options available to inbound ships; to use the shipping channel or not use the channel. The option to follow depends on the arriving ship's draught and the pilot's preference. It would be relatively simple for a passage plan covering each option to be developed and made available/provided to inbound ships well in advance of the ship's arrival at the pilot boarding ground.

This prepared passage plan could then be complemented by the addition of pilotage notes (as currently contained in the Flinders Ports marine operations guidance document for Port Lincoln pilotages) and would allow the bridge team of an arriving ship sufficient time before the pilotage to familiarise themselves with the details of the pilotage and to have the necessary passage information on navigational charts, both paper and/or electronic.

Flinders Ports have a requirement for local shipping agents to lodge an 'application for use of port facilities' form electronically at least two working days before a ship is due to berth in any of Flinders Ports managed ports in South Australia. This is so that a berth and other necessary services, such as pilotage and tugs, can be allocated. There is a section on this form which requests an arrival draught.

Consequently, at least two working days before a pilot is due to board an inbound ship for a Port Lincoln pilotage, the maximum arrival draught of that ship is known. Therefore, the information is known to Flinders Ports well before the pilot boards a ship and a decision about whether to use the channel or not can be made by the allocated pilot well before boarding.

The pilot could then annotate a current 'blank' passage plan before that plan is forwarded to the ship. Alternately, Flinders Ports could develop a standardised pilotage passage plan for either a channel or non-channel passage and each plan then be made available online for the ship to obtain, after being informed which passage the pilot wishes to use.

Grand Rodosi had been at anchor for 5 days before the Port Lincoln pilot boarded. There was no reason that a completed pilotage passage plan, as described above, could not have been forwarded to the ship prior to the pilot boarding on 8 October.

2.9.3 Tug master assistance in the pilotage

The focus of BRM is, as the name suggests, the bridge and the interaction between the members of the bridge team. However, a valuable source of information and assistance which is all too often neglected during any ship handling manoeuvre is the inclusion of the master of an assisting tug in the BRM process.

The tug master is removed from happenings on the bridge but can provide external information which those on the bridge do not have access to, specifically what is happening external to the ship itself. Therefore, an experienced tug master can be part of a pilot's early warning system and as such, forms a valuable defence against a single person error. So it is important that an environment of mutual trust and cooperation exists between a pilot and the master of the tugs assisting in any manoeuvre.

In a paper published in *The Nautical Institute on Pilotage and Shiphandling*[29], the importance of this relationship is discussed:

> To discharge those responsibilities [the legal aspects of the towage on the pilot for the actions of the tug and the pilot's duty of care to the ship in his charge and the vessels employed to tow it] the achievement of a good working relationship between the tug master and pilot, based on mutual trust and confidence in the other's intentions and abilities, is essential and a pilot's training must therefore be aimed at fostering this confidence and cooperation at an early stage.
>
> The safe and timely manoeuvring of ships therefore relies on the team effort of the pilot and tug master. The effectiveness of this team effort further relies on the mutual trust and cooperation between both parties and this trust and cooperation has to be built up over a period of time....
>
> It is important that the tug master and pilot enjoy the closest possible cooperation, and therefore it is a vital element of pilot training that this cooperation ... is fostered at the earliest possible stage.

Additionally and in support of this, comment from the manager of Port Ash is that:

> This [assistance] can be prompted by pilots or can be unprompted and spontaneous as part of the pride of participating in team work.
>
> Such voluntary comment makes for genuine teamwork instead of tug masters merely responding to the pilot's orders. The pilot will be getting some assistance in preventing a one-person error of judgement. But unless they have all discussed these aspects of working together or have trained together, this may not happen. We often see this here [at Port Ash] when smaller ports bring their tug masters for a port workshop. Typical comment from tug masters is that it is first time they have ever overheard the pilot and can now better see their place in the overall scheme of things.

However, during *Grand Rodosi*'s turn on 8 October, neither tug master provided any comment on how fast the ship may have been moving ahead, the distance off the fishing vessel or the direction of rotation of the propeller. The voyage data recorder data shows that it was not until after the collision, while the ship was embedded in *Apollo S*, that any comment was offered to the pilot.

Had there been early advice from a tug master like 'getting a bit close forward' from the forward master and/or 'your engine is still going ahead' from the after tug master, the pilot might have realised earlier that things were not going as he expected and he could have reacted earlier to take corrective action.

Port Lincoln is not a large port. It has a regular pilot and regular crews manning the two tugs in the port. Therefore, there should be an effective and cooperative relationship between the pilot and tug masters. This relationship should extend to inclusion in pilotage plans, decision making and enhanced communications to further the interaction between the parties during pilotage.

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29 Hazell, R. F. Marks, D. & Adams, A. *Pilotage and Towage*. The Nautical Institute, London 1990, p51 to 55.

Not only should individual pilots and tug masters be aware of the valuable input a tug master can provide a pilotage but the organisations responsible for the provision of pilotage and tug services in a port should have processes in place to encourage the practice and routinely train pilots and tug masters together so that they become used to working better as a team.

2.10 Use of English on the bridge

Chapter V, regulation 14.4 of SOLAS states:

> On ships to which chapter I applies, English shall be used on the bridge as the working language for bridge-to-bridge and bridge-to-shore safety communications as well as for communications on board between the pilot and bridge watchkeeping personnel, unless those directly involved in the communications speak a common language other than English.

Sections 1.2.11 (Use of English) and 1.2.12 (The bridge team and the pilot) of the *Bridge Procedures Guide*[30] states that:

> Communications within the bridge team needs to be understood. Communications between multilingual team members, and in particular with ratings, should either be in a language that is common to all relevant bridge team members or in English.
>
> When a pilot is on board, the same rules should apply...

With regard to the use of English on the bridge, the same principle applies to communications between the bridge and the engine control room. This is particularly important when the communications are directly related to operational issues. Like communications between bridge team members, the use of English in communications between the bridge and engine control room enable the pilot to be aware of issues which could have an influence on his conduct of the ship.

On 8 October, as *Grand Rodosi* closed on *Apollo S*, the pilot asked for confirmation that the ship's engine was at full astern. In response, the master asked the chief engineer if it were possible to increase the rpm astern. However, the conversation was in Tagalog and the pilot could not understand what was being said. This did not allow the pilot the option of overhearing the conversations, which would have been the case had they been speaking in English.

At around the same time, the pilot directed that the port anchor be let go. The master relayed this to the chief mate on the ship's forecastle but again in Tagalog. A similar conversation between the two men was held after the collision when the chief mate explained that he had not let the port anchor go.

The use of Tagalog caused the pilot concern because he felt that he had been 'left out of the loop'.

All operational discussions on *Grand Rodosi*'s bridge, and between the master and crew members in the engine control room, should have been in English, in accordance with the relevant sections of SOLAS and the Bridge Procedures Guide, so that the pilot had an appreciation of what was being said or discussed.

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30 International Chamber of Shipping, 4th edition 2007, page 20 – 21.

3 FINDINGS

3.1 Context

At about 1450 on 8 October 2010, the partially loaded Liberian registered bulk carrier *Grand Rodosi* collided with the fishing vessel *Apollo S* in Port Lincoln, South Australia. As a result of the collision, *Apollo S* was crushed against the wharf and sank shortly afterwards. *Grand Rodosi* sustained several relatively small holes in its bow's shell plating.

From the evidence available, the following findings are made with respect to the collision on 8 October 2010. They should not be read as apportioning blame or liability to any particular organisation or individual.

3.2 Contributing safety factors

- At 1446¾, when the first astern movement was ordered, *Grand Rodosi*'s chief engineer, who was manually operating the main engine during the passage to the berth, did not allow sufficient time for the starting air to brake the main engine before re-admitting fuel. Consequently, the main engine which was still turning ahead, started the 'wrong way' and ran in the ahead direction rather than astern.
- No one on the ship's bridge or in its engine control room noticed that the main engine continued to run in the ahead direction.
- When the main engine was operated in engine room control mode, there was no automatic interlock to prevent 'wrong way' operation of the engine and no audible alarm to indicate when it was running the 'wrong way'. As a result, the only system protections to warn the crew of 'wrong way' running of the engine were the bridge and engine control room console mounted flashing light indicators. *[Significant safety issue]*
- Newlead Bulkers had not implemented any procedures or guidance to inform the crew that extra vigilance was required when operating the main engine in engine room control mode because there was no automatic interlock to prevent 'wrong way' operation of the engine and no audible alarm to indicate when it was running the 'wrong way'. *[Significant safety issue]*
- *Grand Rodosi*'s speed in the starboard turn approaching the berth did not allow the pilot time to make considered decisions when things did not go according to his plan.
- While the Flinders Ports passage plan for Port Lincoln contained information relating to general navigation in the port, such as depths and navigation/channel marks, it did not contain actual passage specific information, such as courses and speeds to be followed. If the plan had contained course and speed information, the ship's crew would have been better prepared for the pilotage. *[Significant safety issue]*
- The master/pilot exchange did not cover the essential details required under the Flinders Ports marine operations guidance document for Port Lincoln. The exchange should have included important information including the courses to be followed, speeds at critical parts of the passage, and how the pilot would turn the ship.

- Flinders Ports had not undertaken a risk assessment, or developed contingency plans for this specific shiphandling manoeuvre in Port Lincoln. Consequently, the pilot had no guidance regarding what actions to take if the berthing manoeuvre did not progress as he planned. *[Significant safety issue]*
- Effective bridge resource management principles were not followed on board *Grand Rodosi*. Consequently, the bridge team did not know what courses the pilot was following and what speed the ship should be at in critical parts of the pilotage. This resulted in the absence of a shared mental model of the pilotage passage.

3.3 Other safety factors

- *Grand Rodosi*'s master did not inform the pilot during the master/pilot exchange that the ship's main engine would be operated in engine room control mode.
- The participation of the two tug masters in the pilotage process was not actively encouraged in Port Lincoln. Consequently, it was not until after the collision that one of the tug masters advised the pilot that the ship's main engine was still running ahead. *[Minor safety issue]*
- On several occasions, conversations between crew members were conducted in Tagalog. Consequently, the pilot, who did not speak Tagalog, did not know what was being discussed.

4 SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

4.1 Newlead Bulkers

4.1.1 Disabling of the main engine control system

Significant safety issue

When the main engine was operated in engine room control mode, there was no automatic interlock to prevent 'wrong way' operation of the engine and no audible alarm to indicate when it was running the 'wrong way'. As a result, the only system protections to warn the crew of 'wrong way' running of the engine were the bridge and engine control room console mounted flashing light indicators.

Response from Newlead Bulkers

Newlead Bulkers have advised the ATSB that before the ship departed Port Lincoln, audible alarms were fitted in the engine control room and on the bridge to alert the crew to wrong way running of the main engine. Also, in order to overcome the lack of system defences, additional standing orders were developed and posted on the bridge requiring the crew member who is in control of the main engine telegraph to not only clearly repeat telegraph orders but also inform the master and pilot of the main engine response in terms of directions and RPM.

Additional standing orders were placed in conspicuous place in engine control room requiring an engineer officer to stand at the local controls of main engine (engine side) when entering ports, leaving ports, under pilotage or every time main engine is to be manoeuvred, in order to monitor the visual indicators that confirm the correct engine rotation and report immediately any abnormalities to engine control room.

A thorough investigation was also undertaken by the company's technical department to examine if similar circumstances existed on other ships in our fleet, e.g. equipped with same or similar type of engine and controls, with the purpose of identifying whether there was a risk of reoccurrence and to introduce the appropriate preventive measures.

ATSB assessment of response

The ATSB is satisfied that the safety action taken by Newlead Bulkers adequately addresses the safety issue.

4.1.2 Crew guidance

Significant safety issue

Newlead Bulkers had not implemented any procedures or guidance to inform the crew that extra vigilance was required when operating the main engine in engine room control mode because there was no automatic interlock to prevent 'wrong way' operation of the engine and no audible alarm to indicate when it was running the 'wrong way'.

Response from Newlead Bulkers

The advice received from Newlead Bulkers in relation to the safety issue listed in section 4.1.1 above is also applicable to this safety issue.

ATSB assessment of response

The ATSB is satisfied that the safety action taken by Newlead Bulkers adequately addresses the safety issue.

4.2 Flinders Ports

4.2.1 Port Lincoln pilotage passage plan

Significant safety issue

While the Flinders Ports passage plan for Port Lincoln contained information relating to general navigation in the port, such as depths and navigation/channel marks, it did not contain actual passage specific information, such as courses and speeds to be followed. If the plan had contained course and speed information, the ship's crew would have been better prepared for the pilotage.

Response from Flinders Ports

The ATSB has been advised by Flinders Ports that they are always looking to improve their performance taking account best practice. Following the collision in Port Lincoln, Flinders Ports has assessed the contents of the port's pilotage passage plan and amended it to include courses and speed zones.

ATSB assessment of response

The ATSB is satisfied that the action taken by Flinders Ports adequately addresses this safety issue.

4.2.2 Risk assessment of the pilotage

Significant safety issue

Flinders Ports had not undertaken a risk assessment, or developed contingency plans for this specific shiphandling manoeuvre in Port Lincoln. Consequently, the pilot had no guidance regarding what actions to take if the berthing manoeuvre did not progress as he planned.

Response from Flinders Ports

The ATSB has been advised that following the incident, Flinders Ports reviewed its risk assessments and contingency plans, together with a number of different manoeuvres for berthing. Taking into account the characteristics of the incident (engine going ahead rather than astern), similar risks were observed in all manoeuvres.

Flinders Ports has updated the risk assessments for manoeuvring and berthing a ship in the port. The Pilot and Port Notes have also been amended to take the risks and different manoeuvres into account. These notes now include courses and speeds to be followed during manoeuvring within the port.

ATSB assessment of response

The ATSB is satisfied that the action taken by Flinders Ports adequately addresses this safety issue.

4.2.3 Tug masters and pilotage operations

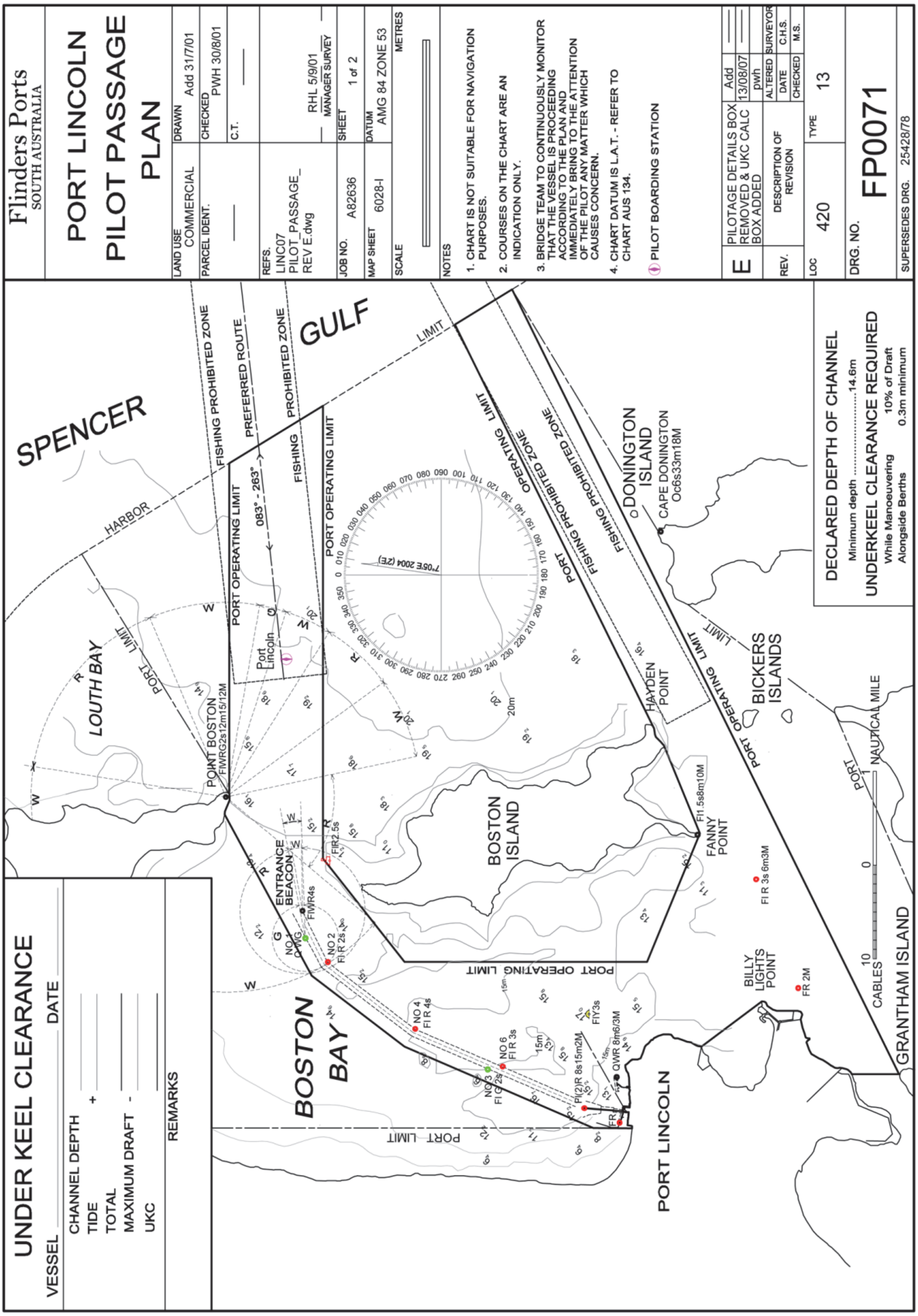
Minor safety issue

The participation of the two tug masters in the pilotage process was not actively encouraged in Port Lincoln. Consequently, it was not until after the collision that one of the tug masters advised the pilot that the ship's main engine was still running ahead.

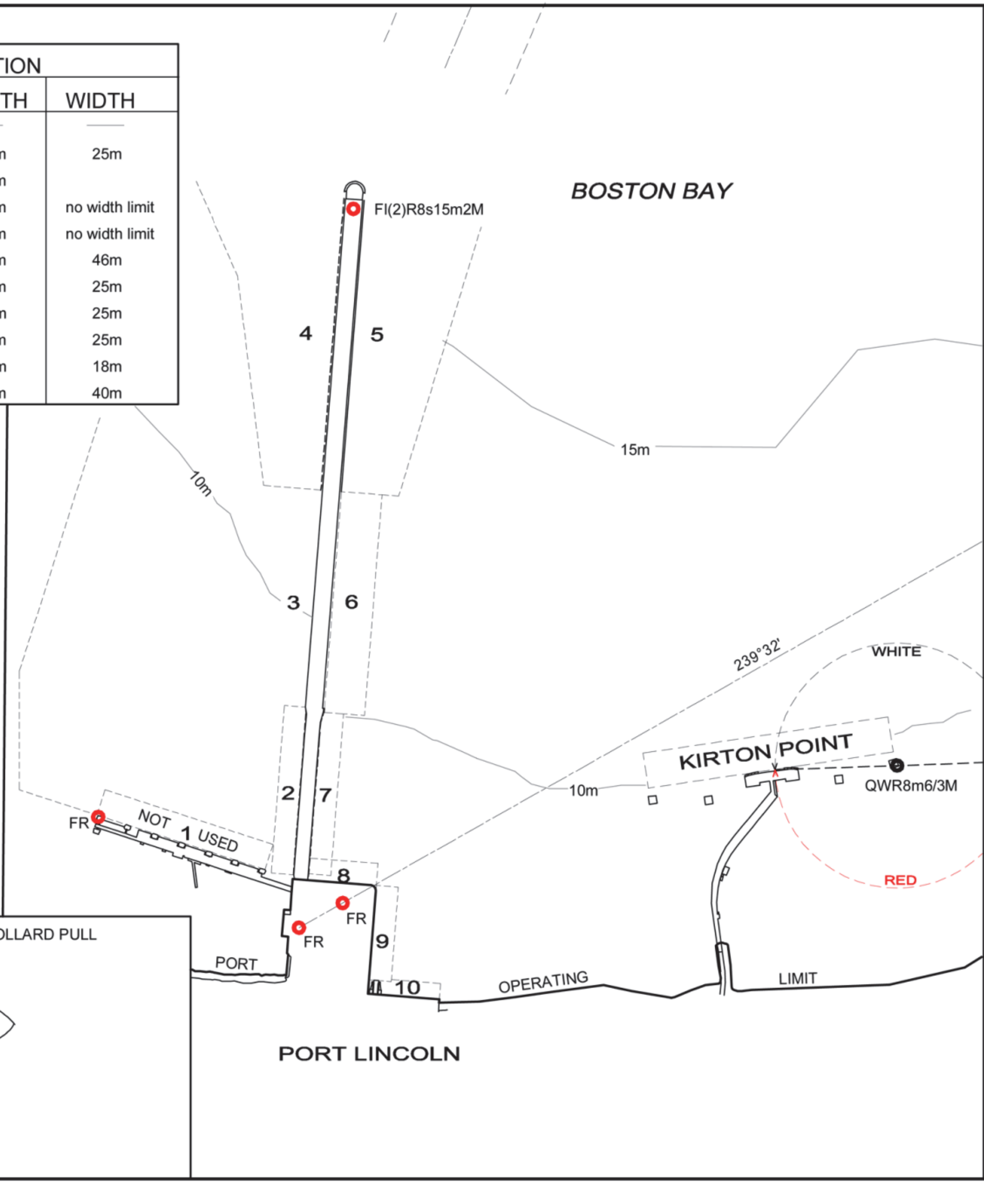
Response from Flinders Ports

The ATSB has been advised by Flinders Ports that, as part of the bridge resource management processes in all Flinders Ports' ports, the following takes place: regular tug master and pilot meetings are conducted; BRM and Advanced BRM training for pilots; and tug masters are also familiarised with the pilot passage plan and are encouraged to engage with the pilot at all times regarding speed, approach and any safety issues that can be seen from the tug.

APPENDIX A : PORT LINCOLN PILOT PASSAGE PLAN



BERTH INFORMATION			
BERTH	DEPTH	LENGTH	WIDTH
NO 1	—	—	—
NO 2	8.7m	190m	25m
NO 3	NOT DEC	246m	
NO 4	15.2m	330m	no width limit
NO 5	15.2m	330m	no width limit
NO 6	12.2m	250m	46m
NO 7	8.4m	183m	25m
NO 8	6.3m	77m	25m
NO 9	5.7m	107m	25m
NO 10	2.7m	56m	18m
KIRTON POINT	9.9m	280m	40m



TUG ARRANGEMENT, TYPE & BOLLARD PULL

ETA TO TUG: ....

TUG NAME: ....

TUG BOLLARD PULL: ....

Flinders Ports
SOUTH AUSTRALIA

PORT LINCOLN PILOT PASSAGE PLAN

LAND USE	COMMERCIAL	DRAWN	Add 6/7/01
PARCEL IDENT.	________	CHECKED	PWH 30/8/01
		C.T.	________
REFS.	LINC03 PASSAGE PLANS PILOT_PASSAGE_2 .dwg	MANAGER SURVEY	RHL 5/9/01
JOB NO.	A82636	SHEET	2 of 2
MAP SHEET	6028-I	DATUM	AMG 84 ZONE 53
SCALE			METRES

NOTES

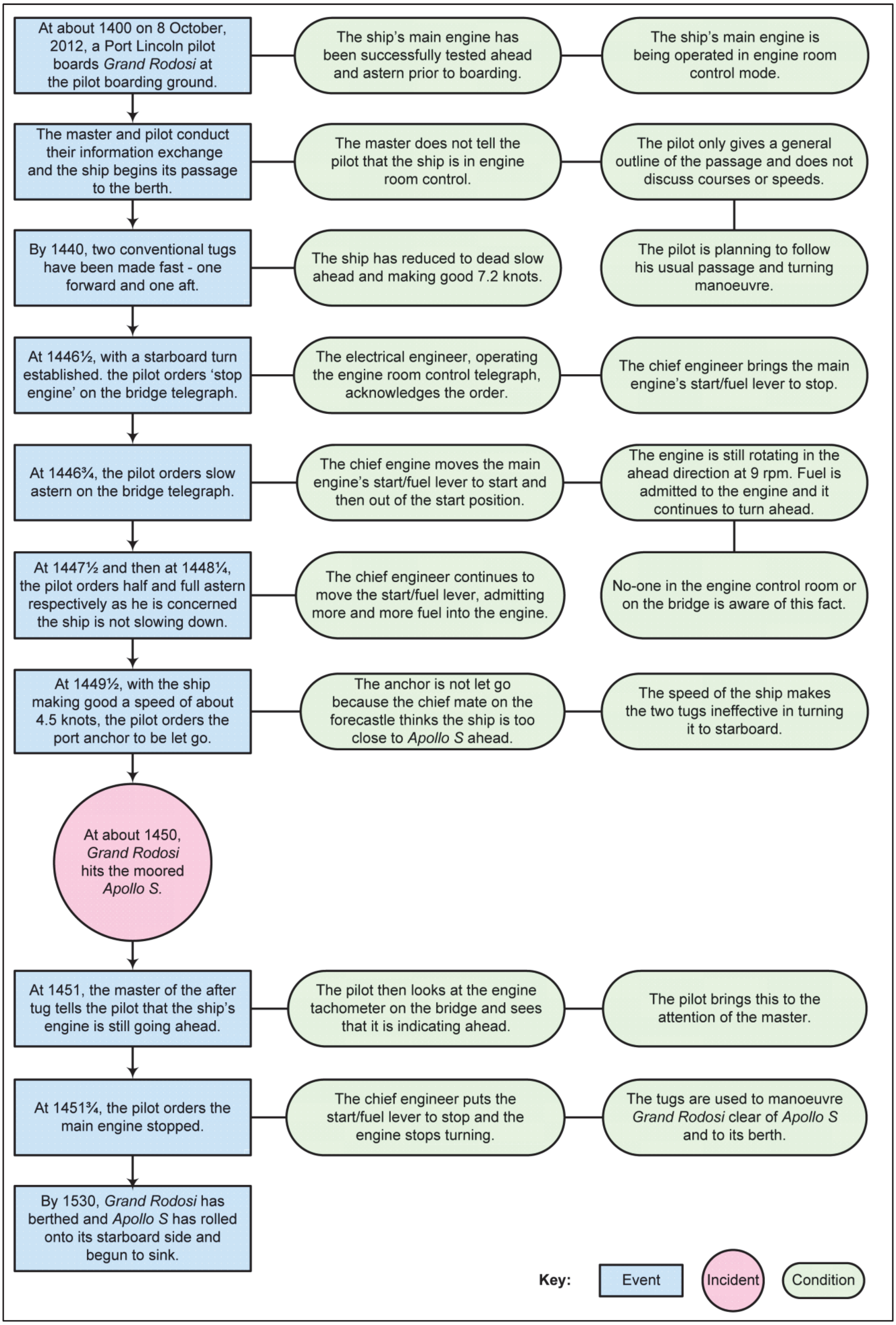
1. CHART IS NOT SUITABLE FOR NAVIGATION PURPOSES.
2. COURSES ON THE CHART ARE AN INDICATION ONLY.
3. BRIDGE TEAM TO CONTINUOUSLY MONITOR THAT THE VESSEL IS PROCEEDING ACCORDING TO THE PLAN AND IMMEDIATELY BRING TO THE ATTENTION OF THE PILOT ANY MATTER WHICH CAUSES CONCERN.
4. CHART DATUM IS L.A.T. - REFER TO CHART AUS 134

D	QA TICKS REMOVED	Add 15/10/04 pwh	
REV.	DESCRIPTION OF REVISION	ALTERED / DATE / CHECKED	SURVEYOR / C.H.S. / M.S.
LOC	420	TYPE	13

DRG. NO. FP0072

SUPERSEDES DRG. 25429/78

APPENDIX B : EVENTS AND CONDITIONS



APPENDIX C : SHIP INFORMATION

Grand Rodosi

IMO number	8800327
Call sign	A8LF4
Flag	Liberia
Port of Registry	Monrovia
Classification society	Bureau Veritas (BV)
Ship Type	Bulk carrier
Builder	Hyundai Heavy Industries
Year built	1990
Owners	Grand Rodosi Inc
Ship managers	Newlead Bulkers
Gross tonnage	37,519
Net tonnage	22,604
Deadweight (summer)	68,788 tonnes
Summer draught	13.2155 m
Length overall	225 m
Length between perpendiculars	215 m
Moulded breadth	32.2 m
Moulded depth	18.3 m
Engine	MAN B&W 6S60MC
Total power	8,994 kW
Service speed	14 knots
Crew	24

Apollo S

IMO number	856834
Call sign	VM6140
Flag	Australia
Port of Registry	Port Lincoln
Classification society	American Bureau of Shipping (ABS)
Ship Type	Fishing vessel
Builder	Port Lincoln Marine Services
Owners	Australian Fishing Enterprises
Gross tonnage	1,008
Net tonnage	22,604
Summer draught	13.2155 m
Length overall	46.95 m
Moulded breadth	10.7 m
Moulded depth	6.92 m
Engine	Wartsila 9L20
Total power	1,500 kW
Service speed	13 knots
Crew	14

APPENDIX D : SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included:

Grand Rodosi's master and crew

The pilot

Tug *Wangary*'s master

Flinders Ports

Newlead Bulkers

The Australian Maritime Safety Authority

The Australian Ship Handling Centre (Port Ash)

References

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Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the Transport Safety Investigation Act 2003, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to *Grand Rodosi*'s master, third mate and chief engineer, Newlead Bulkers, the Port Lincoln pilot, the Port Lincoln harbour master, Flinders Ports, Bureau Veritas, MAN Diesel & Turbo Australia, the Liberian International Ship and Corporate Registry, Coates Lawyers (representing the owners of *Apollo S*), the Australian Maritime Safety Authority (AMSA) and the South Australian Department of Transport, Energy and Infrastructure.

Submissions were received from Newlead Bulkers, the Port Lincoln pilot, the Port Lincoln harbour master, Flinders Ports, Bureau Veritas, Coates Lawyers, AMSA and the South Australian Department of Transport, Energy and Infrastructure. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Marine Occurrence Investigation
Collision between the Liberian bulk carrier *Grand Rodosi* and the Australian fishing vessel *Apollo S*
279-MO-2010-008
Final