Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT
Marine Occurrence Investigation No. 223
Final

Independent investigation into the grounding of the Indian registered oil tanker

Desh Rakshak

in the entrance to Port Philip, Victoria

4 January 2006

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Postal address: PO Box 967, Civic Square ACT 2608
Office location: 15 Mort Street, Canberra City, Australian Capital Territory
Telephone: 1800 621 372; from overseas + 61 2 6274 6440
Accident serious incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6274 6474; from overseas + 61 2 6274 6474
E-mail: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

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The satellite image of Port Phillip was downloaded from the Port Phillip Sea Pilots website.

Abstract

Desh Rakshak arrived off Port Phillip on the morning of 4 January 2006, with about 80 000 tonnes of crude oil cargo on board, and at 0800 a pilot boarded the ship for the transit from sea to the Melbourne outer anchorage.

The pilot planned to enter the port to the west of the track marked by the main leading lights, to keep the ship out of an opposing tidal flow for as long as possible. When the ship was almost abeam of Point Lonsdale Lighthouse, the pilot thought he could see the high and low main leading lights just open to the west. This indicated to him that the ship was on the edge of the Great Ship Channel. However, the ship was further to the west than the pilot thought.

The ship continued the transit and anchored at 1154. No one on board the ship observed anything that might have suggested that the ship had grounded during the pilotage.

At about 1245, the chief mate found the level in the lower fore peak water ballast tank rising. He told the master, and they decided to pump out the tank and inspect it. The inspection revealed that the tank's shell plating had been holed.

The ship berthed in Geelong on 5 January and temporary repairs were carried out before it sailed for Singapore on 19 January, where it was dry-docked for permanent repairs.

The investigation found that the ship probably grounded at about 0825, when it was almost abeam of Point Lonsdale, while transiting from sea to the Melbourne outer anchorage.

The report identifies a number of contributing factors and makes recommendations to address them.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal Bureau within the Australian Government Department of Transport and Regional Services. ATSB investigations are independent of regulatory, operator or other external bodies.

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 enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, 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 proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

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, risk controls and organisational influences.

Contributing safety factor: a safety factor that, if it had not occurred or existed at the relevant time, then either: the occurrence would probably not have occurred; or 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.

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.

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

- **Critical safety issue**: associated with an intolerable level of risk.
- **Significant safety issue**: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable.
- **Minor safety issue**: associated with a broadly acceptable level of risk.

EXECUTIVE SUMMARY

Desh Rakshak sailed from Sydney on 2 January 2006, with about 80 000 tonnes of crude oil cargo on board, and arrived off Port Phillip on the morning of 4 January. The ship was on an even keel with a static draught of 11.5 m.

At 0800, a pilot boarded the ship for the transit from sea to the Melbourne outer anchorage. When the pilot arrived on the bridge, he was handed the ship's pilot card. He then explained to the master how the tide flowed through the heads, from north to south, and that the ship would be stemming a strong ebb tide during this part of the passage. The flow of the ebb tide also meant that the ship would be set to the east as it was passing through the port's entrance. The pilot outlined his intention to enter to the west of the track marked by the main leading lights, keeping the ship on the western side of the Great Ship Channel (the main channel) for as long as possible and out of the tidal flow.

The pilot called the Lonsdale Signal Station for clearance to enter the port. He also asked for the tide heights at the Rip Bank and Hovell Pile. The tides were 1.1 m and 0.8 m above chart datum, respectively. The pilot calculated that the ship's under keel clearance would be no less than 3.5 m during the transit of the Great Ship and South Channels.

There was a long low swell from the south-southwest, the wind was from the same direction at 20 to 25 knots and the sea was choppy. The ship's stern was being picked up by successive swells and the ship was riding the waves. The ship was also yawing and rolling slowly through about five degrees at times. The tidal stream was running at five to six knots, faster than the pilot had anticipated.

As the ship entered the Lonsdale Lighthouse red sector, with the lighthouse bearing 325° (T), the pilot thought he could see the high and low main leading lights just open to the west. This indicated to him that the ship was on the western edge of the Great Ship Channel. However, the ship was further to the west than the pilot thought.

The ship continued the passage, passing without incident through the South Channel before anchoring at 1154. The pilot disembarked shortly thereafter. No one on board the ship observed anything that might have suggested that the ship had grounded during the pilotage.

At about 1245, the chief mate discovered that the level in the lower fore peak water ballast tank was rising. He informed the master, and they decided to pump out the tank and inspect it. When the tank was almost empty, an inspection revealed that the tank's shell plating had been holed.

The ship berthed in Geelong on 5 January, and an underwater inspection of the hull was carried out while the cargo was being discharged. Temporary repairs were then completed under the supervision of a class surveyor.

On 19 January, the ship sailed for Singapore, where it was dry-docked for permanent repairs.

The investigation found that:

- *Desh Rakshak* probably grounded in the Western or Outer Western Ship Channels at about 0825, when the ship was almost abeam of Point Lonsdale.
- The ship's under keel clearance was less than the bridge team had anticipated.
- Port Phillip Sea Pilots procedures did not give effective guidance to the pilot when deciding whether, or not, to pilot the ship from sea to the Melbourne outer anchorage in the prevailing conditions.
- The inadequate application of bridge resource management principles led to the ship's bridge team having little effective input during the pilotage passage.
- The bridge team did not effectively use the echo sounder to monitor the depth of water under the ship's bow.

Safety actions taken:

- On 16 March 2006, the Port of Melbourne Corporation issued a notice to mariners revising the definition of the pilot boarding ground.
- Port Phillip Sea Pilots instigated a review of their procedures and practices prior to the grounding of *Desh Rakshak*, with consultants tasked to review the company's safety management system.
- Port Phillip Sea Pilots are in the process of providing each pilot with a laptop computer, loaded with the latest electronic charts and company approved standard courses. The pilots will also receive training in the use of these units.
- Port Phillip Sea Pilots have implemented a procedure that ensures that all expected transits of deep draught tankers and other low powered vessels are checked by the pilot in charge to determine if a passage through the 'Heads' is safe given the vessel's estimated time of arrival.

The report recommends that:

- Port Phillip Sea Pilots should review their training, procedures and practices to ensure that pilots implement all aspects of bridge resource management.
- Port Phillip Sea Pilots should review their procedures and practices to ensure that pilots board ships at a location that ensures sufficient time is available for the pilot to adequately brief the crew before the ship reaches the port's entrance.
- Port Phillip Sea Pilots should review their procedures and practices to ensure that squat and the ship's movement in the prevailing conditions are adequately considered when it's under keel clearance is calculated.
- The Shipping Corporation of India should review their training, procedures and practices to ensure that all aspects of bridge resource management are implemented on board their ships.
- The Shipping Corporation of India should review the procedures and practices on board their ships in relation to the use and monitoring of echo sounders.

1 FACTUAL INFORMATION

1.1 *Desh Rakshak*

Desh Rakshak is an Indian registered double hulled oil tanker (Figure 1). The ship is owned and managed by the Shipping Corporation of India (SCI), and is classed with the American Bureau of Shipping (ABS).

The ship was built in 2003 by Hyundai Heavy Industries, Ulsan, Korea. It has an overall length of 244.16 m, a beam of 42 m, a depth of 22.6 m and a deadweight of 114 600 tonnes at its summer draught of 13.6 m.

Propulsive power is provided by a six cylinder MAN B&W 6S60MC, single acting, direct reversing, two-stroke diesel engine delivering 10 765 kW. The main engine drives a single fixed pitch propeller which gives the ship a service speed of 13 knots[1].

Figure 1: *Desh Rakshak* berthed in Geelong

Desh Rakshak was equipped with navigational equipment consistent with SOLAS[2] requirements. This included two radars; a JRC JMA-9823-7XA x-band radar and a JRC JMA-9833-7XA s-band radar. The bridge was also fitted with a JRC echo sounder, a global positioning system (GPS) unit, a GPS plotter, an automatic identification system (AIS) unit and a voyage data recorder (VDR).

At the time of the incident, *Desh Rakshak* had a crew of 40 Indian nationals. The mates and engineers maintained a watchkeeping routine of four hours on, eight hours off at all times.

The master held a foreign-going masters certificate of competency, which was first issued in India in 1981. He had 32 years seagoing experience, the last 23 years in command. He had been master of *Desh Rakshak* for two months and was completing his first assignment on the ship. He had been to Geelong several times in the past.

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

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

The third mate, the officer of the watch at the time of the incident, held a foreign-going second mates certificate of competency, which was issued in India in 2004. He had been on board *Desh Rakshak* for ten months. This was his first posting as a third mate.

The deck cadet was also on the bridge at the time of the incident. He had started his cadetship in 2005, and *Desh Rakshak* was his first ship. He had been on board the ship for four months.

The pilot on board *Desh Rakshak* on 4 January 2006 began his seagoing career in 1961. He gained his foreign going masters certificate in Australia in 1973, and his first command in 1982. He joined Port Phillip Sea Pilots in 1984, and received his pilotage licence after six months of training. He had experience piloting all types of ships, including tankers of similar size to *Desh Rakshak*.

Figure 2: Satellite image of Port Phillip

1.2 Port Phillip

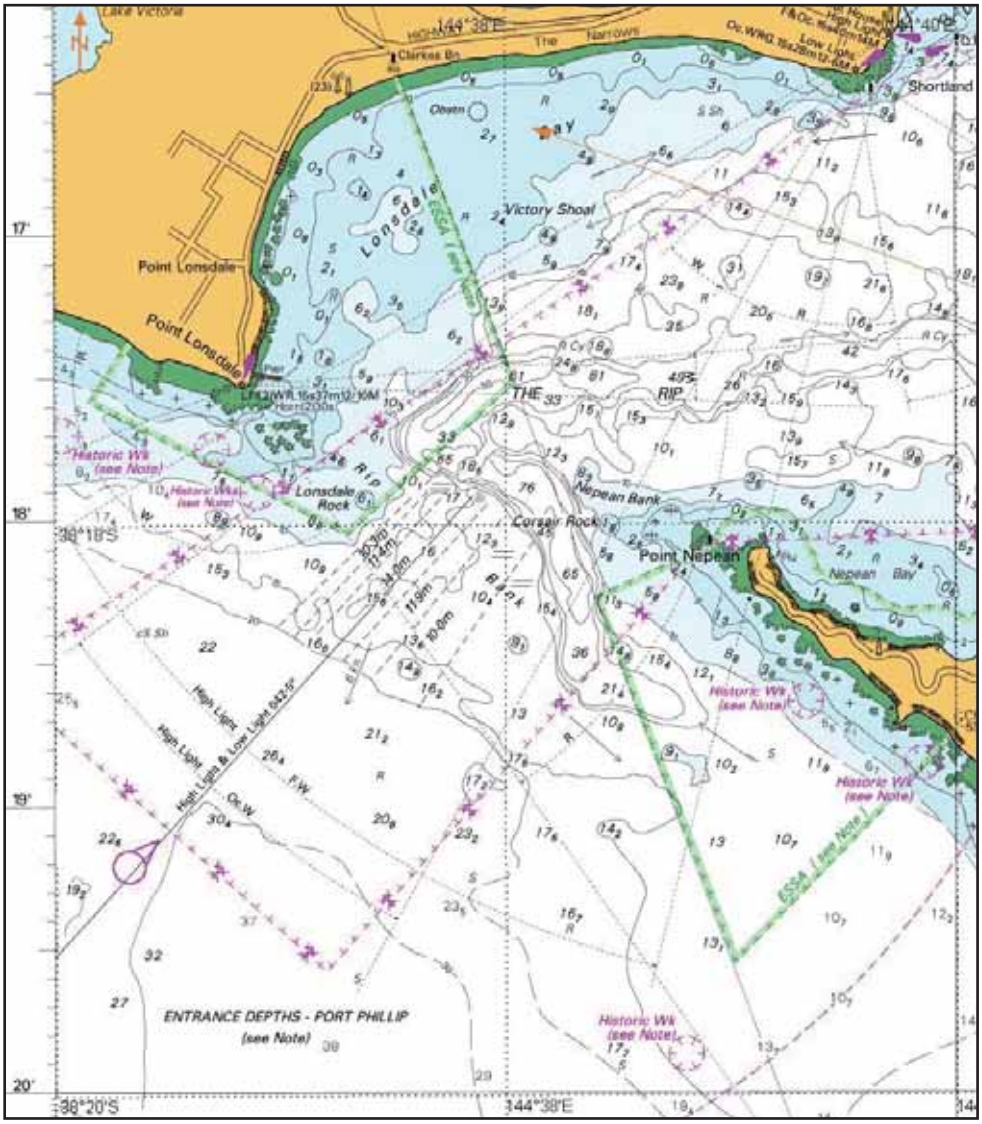
Port Phillip is an extensive bay with a length of over 30 miles[3] from its entrance in the south, to its northern end (Figure 2). The 'Heads', as the outer part of its

3 A nautical mile of 1852 m.

entrance is known, is bounded on the northwest side by Point Lonsdale and on the southeast by Point Nepean, two miles east-southeast of Point Lonsdale.

The port of Geelong is located within Western Arm, on the western side of Port Phillip. Hobson's Bay is formed at the northern end of Port Phillip, into which the River Yarra flows. The port of Melbourne is situated at the head of the bay and within the entrance of the River Yarra.

Figure 3: Section of navigational chart Aus 144 showing the channels in the entrance to Port Phillip



There are five channels leading from sea into Port Phillip that are used by commercial shipping (Figures 2 and 3). The main route leads east-northeast through the channels in the entrance and thence east-southeast along the South Channel to the southern corner of the bay.

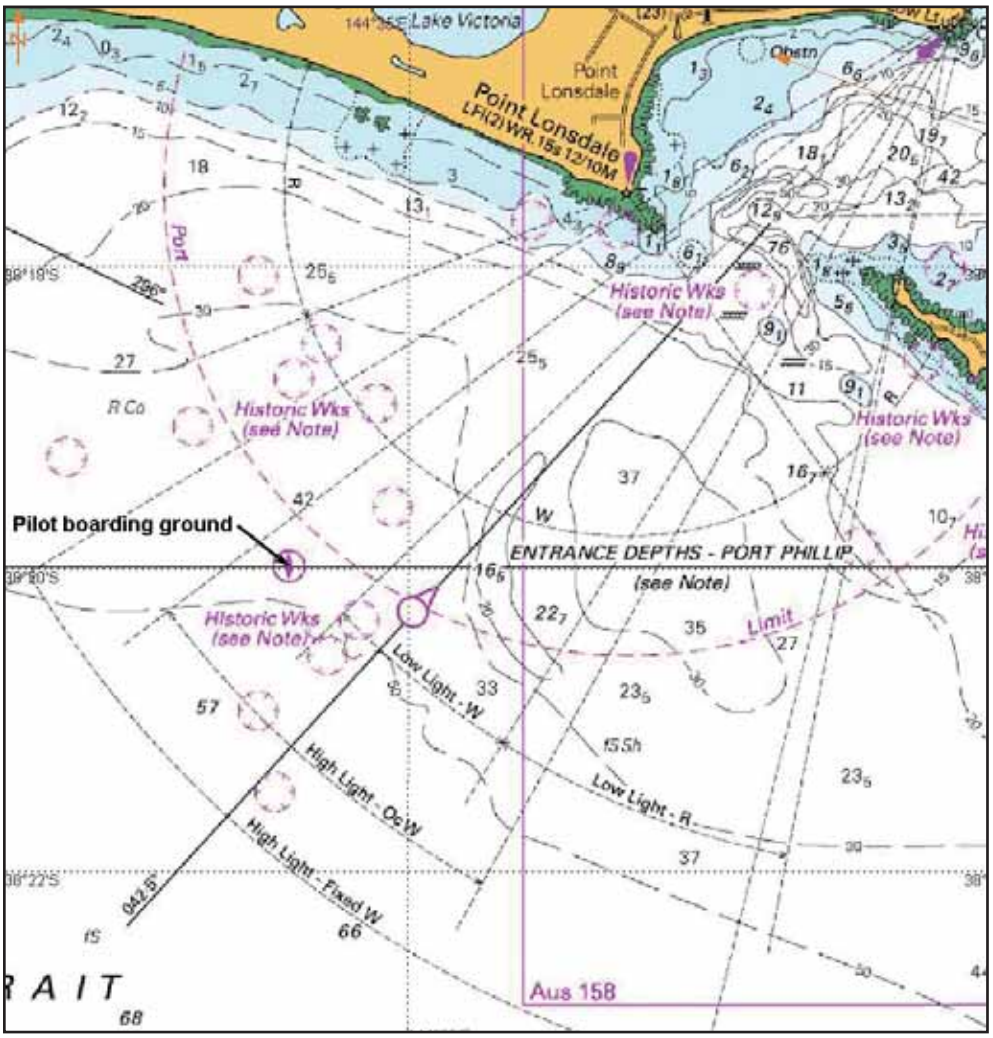
The Great Ship Channel, with a declared depth of 14 m, lies midway between Port Lonsdale and Point Nepean and is about 245 m wide. The centre of the channel is marked by the Queenscliff high and low lights, on a bearing of 042½° (T) from seaward.

The Western Ship Channel lies on the western side of the Great Ship Channel, and has a declared depth of 11.4 m. The Outer Western Channel lies further to the west, and has a declared depth of 10.3 m.

The Eastern Ship Channel lies on the eastern side of the Great Ship Channel, and has a declared depth of 11.9 m. The Outer Eastern Channel lies further to the east, and has a declared depth of 10.0 m.

Rip Bank, a rocky flat with depths of between 8.8 and 18.0 m, extends across the entrance of the port, close to the seaward side of the Heads. Along the inner side of Rip Bank lies Entrance Deep, which has depths of between 47 and 94 m. Entrance Deep curves around a 13.6 m patch on the leading line of the channel. The sharp contrast in depths, combined with tidal streams running at rates as high as eight knots at times, creates 'The Rip'. The Rip is a race of water which breaks so heavily during, or immediately after, southwest gales that it can endanger small vessels.

Figure 4: Section of navigational chart Aus 143 indicating the pilot boarding ground.



All pilotage services in Port Phillip are provided by Port Phillip Sea Pilots, a private company that operates subject to licensing by Marine Safety Victoria and safety oversight by the Port of Melbourne Corporation. Pilotage in the port is compulsory for all ships except exempted coastal ships. At the time of the incident the pilot boarding ground was located 3.3 miles southwest of the Point Lonsdale Lighthouse (Figure 4).

The Lonsdale Signal Station, located at the base of Point Lonsdale Lighthouse, provides a vessel traffic service (VTS) for ship movements in the Heads and the South Channel.

Before tankers transit through the port's entrance, the master or pilot is required to notify VTS of their intentions. During a tanker's transit, the entrance is closed to all other traffic, enabling the tanker to have exclusive use of the entrance channels.

The Port of Melbourne Corporation is in the process of seeking final government approval to deepen the shipping channels in the Port Phillip entrance. In August 2005, a limited scale trial dredging program in the entrance area was carried out with a view to proving the proposed rock dredging technology and determining possible environmental impacts. The trial work was restricted to a 'wedge' shape within the Western Ship Channel and the Outer Western Channels. The Port of Melbourne Corporation anticipates that the dredging program will be completed by 2009 if approval for the project is granted. On completion of the dredging, a depth of 17.0 m will be declared in the Great Ship Channel and the trial 'wedge'.

1.3 The incident

Desh Rakshak sailed from Gore Bay, Sydney, on the evening of 2 January 2006, after discharging part of its crude oil cargo. The ship was on an even keel, with a static draught of 11.5 m. About 80 000 tonnes of cargo remained on board.

During the voyage to Geelong, *Desh Rakshak* experienced winds of 15 to 25 knots and a swell of three to four metres, both from the southwest. The master anticipated that he would be anchoring the ship when it arrived off Port Phillip while waiting for a pilot.

At about 0500[4] on 4 January, the master contacted Port Phillip Sea Pilots, using the ship's very high frequency (VHF) radio. He informed the pilot dispatch officer that the ship's estimated time of arrival at the pilot boarding ground had come forward from 1000 to 0800.

The next available pilot was asked by the pilot dispatch officer if, with a revised arrival time of 0800, the ship could be piloted from sea to the Melbourne outer anchorage. The pilot decided that this would be possible and confirmed so with the pilot dispatch officer. The master was then informed that a pilot would board *Desh Rakshak* on its arrival at the pilot boarding ground.

The master instructed the second mate to mark the courses on the ship's charts for the transit to the Melbourne outer anchorage and, when he was finished, the master checked the marked courses to ensure they were correct. The ship's crew carried on

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

with their normal duties and at 0730 the daily soundings of the ship's ballast water tanks were completed. The soundings confirmed that the condition of the tanks was unchanged from the previous day.

At about 0735, two pilots boarded the pilot boat at the Queenscliff Pilot Station. One of the pilots was for *Desh Rakshak* and the other was for a car carrier that was to enter the port just before *Desh Rakshak*. The pilot boarded the car carrier at 0750 when it was about two miles off the heads. The pilot boat then set a course to meet *Desh Rakshak* just to seaward of the pilot boarding ground, about four miles southwest of Point Lonsdale.

The pilot contacted *Desh Rakshak* by VHF radio and requested that the ship maintain a speed of 12 knots and a heading of 340° for pilot boarding. The pilot had asked for a speed faster than the normal boarding speed of 10 knots as he had been told by another pilot that the ship was 'a little under powered', and the ebb tide was approaching its strongest flow. He felt that the ship needed to build up as much speed as possible to make it easier to navigate through the Heads. At about this time the ship's steering was placed into hand control and the helmsman took the wheel.

At 0800, the pilot boarded *Desh Rakshak*, and as soon as he climbed off the pilot ladder and onto the ship's main deck, he used the third mate's hand held radio to ask the master to bring the ship around to a heading of 070° and increase the ship's speed to navigation full ahead[5].

The pilot was escorted to the bridge by the third mate and the deck cadet. When he arrived on the bridge the ship's heading was 065°, and it soon steadied on 070°. The ship's speed had fallen to 10.5 knots over the ground and, when he queried the lower than expected speed, the pilot was told that the speed had decreased during the turn, and that the main engine revolutions were still building up.

The bridge team included the pilot, the master, the third mate, a deck cadet and a helmsman. The ship's pilot card was passed to the pilot and a short discussion took place between the pilot and the master. They then moved to the chart table and discussed the pilot's passage plan.

The pilot explained how the ebb tide flowed through the Heads, from north to south, and that the ship would be stemming a strong tidal flow during this part of the passage. The direction of the tidal stream would also set the ship to the east as it was passing through the port's entrance. The pilot outlined his intention to enter to the west of the track marked by the Queenscliff high and low leading lights, keeping the ship on the western side of the Great Ship Channel for as long as possible (Figure 5). He explained that once the ship was in the tidal flow it would be set to the east, into the Great Ship Channel, and its speed over the ground would fall.

During the information exchange, the pilot calculated an estimated time of arrival at the anchorage, and he assured the master that the ship's minimum under keel clearance (UKC) during the passage would be 3.5 m. The master confirmed that he understood and agreed with the plan, and the pilot then took the conduct of the ship.

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5 A speed used when in open water and usually higher than the speed used for manoeuvring in ports.

The pilot called VTS, using the ship's VHF radio. He checked on local shipping movements and requested clearance to enter the port. He notified VTS of the ship's draughts, asked for the entrance to be closed to all other ships during *Desh Rakshak*'s transit and requested the tide heights at Rip Bank and Hovell Pile. The tide heights at these locations were 1.1 m and 0.8 m above chart datum, respectively.

Figure 5: The pilot's recollection of the course followed by *Desh Rakshak*

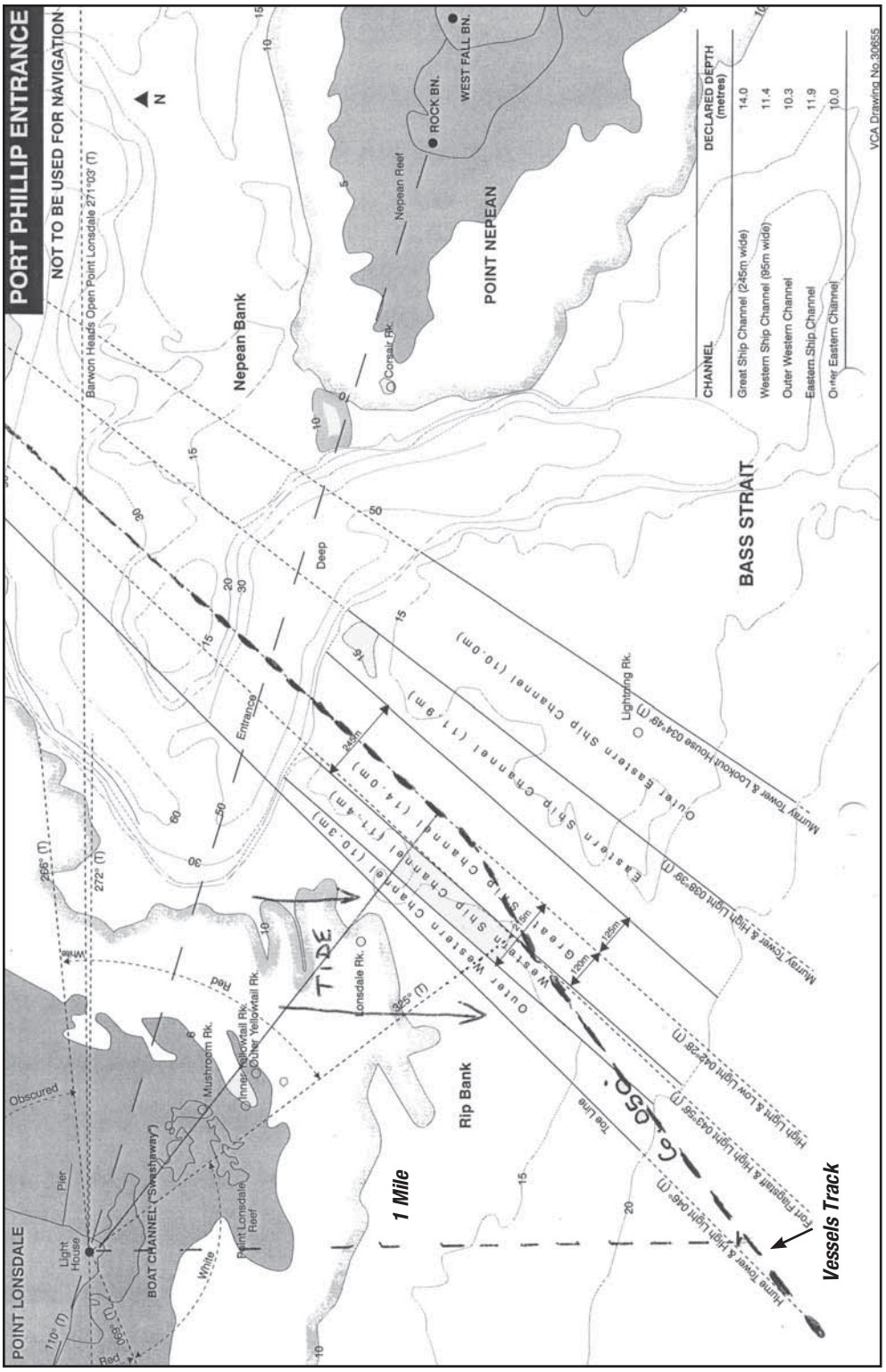
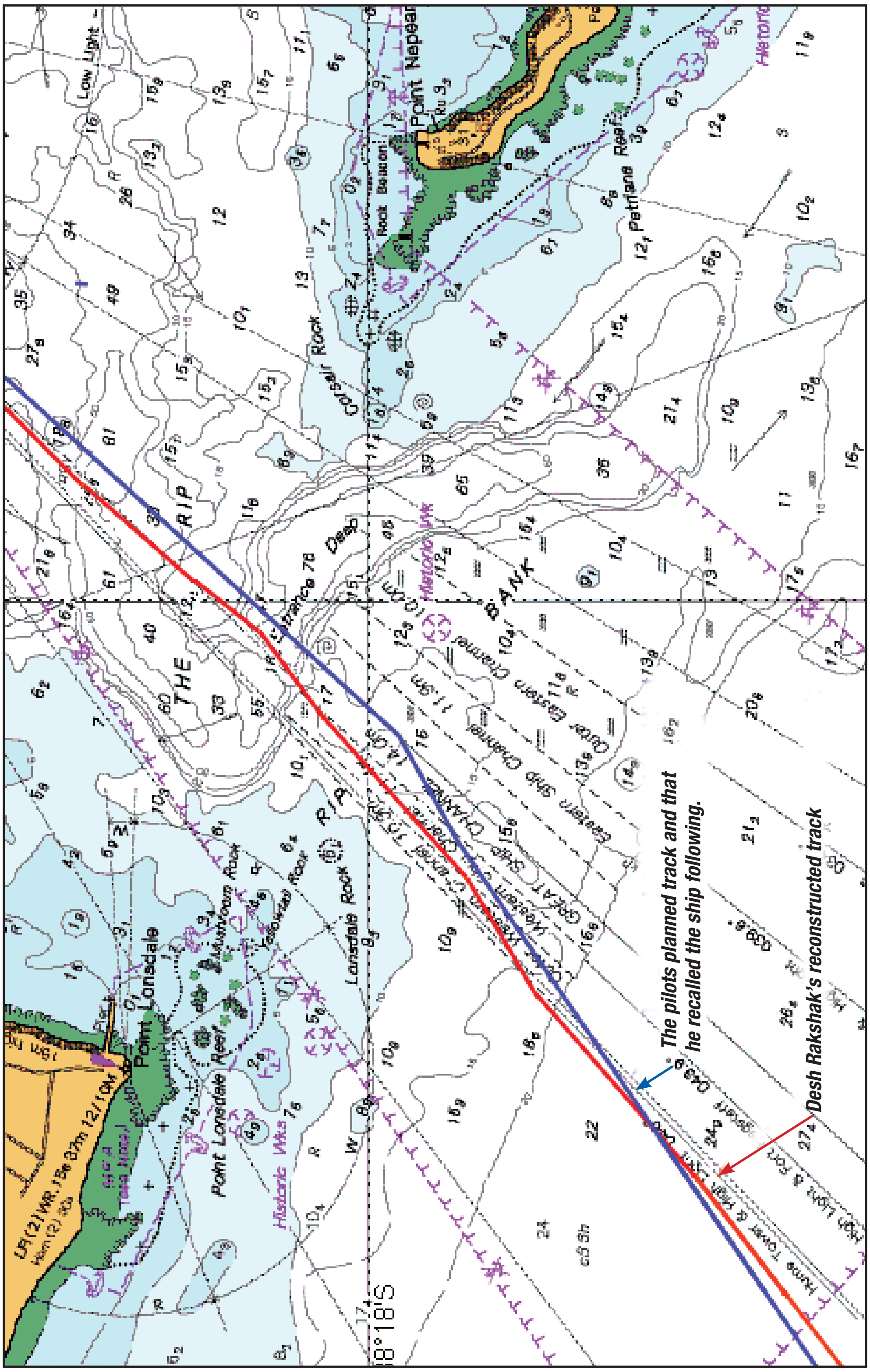


Figure 6: Section of navigational chart Aus 144 showing the pilot's planned track and the ship's reconstructed track.



There was a long low swell from the south-southwest, the wind was from the same direction at 20 to 25 knots and the sea was choppy. The ship's stern was being picked up by successive swells and the ship was riding the waves. The ship was also yawing and rolling slowly through about five degrees at times. The pilot estimated

that the tidal stream was flowing at five to six knots, somewhat faster than he had anticipated. Low tide at the Heads, the time which approximates the time of the maximum ebb tidal stream, was predicted at 0933.

When the ship was about one mile south of Point Lonsdale (Figures 5 and 6), just entering the Outer Western Channel, its speed over the ground was 12.8 knots.

At about 0825, as the ship entered the Lonsdale Lighthouse red sector, with the lighthouse bearing 325° (T), the pilot thought he could see the Queenscliff high and low leading lights just open to the west. This indicated to him that the ship was on the western edge of the Great Ship Channel. However, the ship was further to the west than the pilot thought (Figure 6). The ship's speed had decreased to eight knots over the ground and the swell had started to subside. The swell was being flattened by the strong ebb tide.

The master was visually monitoring the passage while the third mate was using the radar for position fixing. Neither of them were aware that the ship was further to the west than it should have been.

When the ship reached the next course alteration point, its speed had further reduced to 6.8 knots. The pilot brought the ship around to a course of 101°, aligning it with the entrance of the South Channel. The ship continued along the South Channel, staying well within the marked channel at all times, rounding Hovell Pile at about 0945.

After the ship rounded Hovell Pile, the master left the bridge to complete some paper work. He instructed the third mate to call him when the ship reached a particular position that he had marked on the chart.

The master was called as instructed, about two miles before the anchorage, and the anchor was let go in the Melbourne outer anchorage at 1154. Finished with engines was rung at 1212 and, shortly thereafter, the pilot disembarked from the ship.

At no time while entering the port or transiting the South Channel did anyone on the ship observe anything that might have suggested that the ship had grounded. The echo sounder was running throughout the transit and the pilot did not recall seeing any spikes in the sea floor on its display, and did not recall any being brought to his attention.

At about 1245, the chief mate was in the cargo control room checking the cargo oil tank temperatures when he discovered that the level in the lower fore peak water ballast tank was rising. The tank was empty when it was checked at 0730 and the remote gauge was now reading five metres. The chief mate sent the quartermaster to manually sound the tank, while he checked the ballast system. No valves had been inadvertently left open in the ballast system and the manual sounding confirmed the water level in the tank was five metres and rising.

The chief mate informed the master, and together they checked the sounding of the lower fore peak tank, it was now about ten metres. They decided to pump out the tank and check its integrity.

At 1445, de-ballasting of the lower fore peak tank began and at about 1600 the tank was inspected. The inspection revealed nothing abnormal, as there was still too

much water in the tank to see the bottom shell plating. De-ballasting continued and another inspection was carried out when the water level in the tank was lowered to 0.4 m. On this occasion, seawater could be seen gushing into the tank through a hole in the bottom shell plating. The crew could not determine the rate of water ingress, but the water level in the tank was being maintained by the ballast pump discharge.

Arrangements were made for the berthing of the ship. The plan was for the ship to discharge its cargo while a full underwater inspection was carried out. The necessary temporary repairs would then be completed under the supervision of a class surveyor.

The ship berthed in Geelong at 0836 on 5 January. The underwater inspection carried out on 6 January revealed the following damage.

- The lower fore peak water ballast tank shell plating was torn open. The tear was 400 mm long and 250 mm wide, located immediately forward of the fore peak bulkhead and four metres to starboard of the ship's centreline. Large pieces of rock were found in the lower fore peak tank and the fore peak bulkhead was buckled.
- Number one starboard water ballast tank shell plating was set up by 50 mm, in at least two areas, and the tank's framing was buckled.
- Number six port water ballast tank shell plating was set up by 100 mm over an area of 1500 mm x 700 mm. A 200 mm long, 15 mm wide fracture in the shell plating was found about four metres inboard of the turn of the bilge.
- Number five port water ballast tank shell plating was set up by 19 mm over an area of 6780 mm x 2500 mm. The tank's framing was also buckled.

Temporary repairs were carried out in Geelong and the ship sailed for Singapore on 19 January, where it was dry-docked to undergo permanent repairs.

2 ANALYSIS

2.1 Evidence

On 7 January 2006, two investigators from the Australian Transport Safety Bureau (ATSB) attended *Desh Rakshak* in Geelong. The master, chief mate, third mate, cadet and chief engineer were interviewed and relevant documents and records were obtained. The evidence included the course recorder chart, a copy of the navigational chart used, copies of log books, bell books, the engine movement logger printout, passage plans, checklists, the master's statement of facts, standing orders and various procedures.

On 8 January, the investigators interviewed the pilot at the Port Phillip Sea Pilots Melbourne office and obtained his report and copies of other documents.

Information including vessel traffic service (VTS) radar data, sea floor topography and an analysis of the rock found in *Desh Rakshak*'s lower fore peak tank was supplied by the Port of Melbourne Corporation. Automatic identification system (AIS) data was recorded by the Victorian Regional Channels Authority's Geelong receiver.

Since the ship's crew were not aware that the ship had grounded during the transit of the Port Phillip entrance, no effort had been made to backup the data stored in the ship's voyage data recorder (VDR). Consequently, no relevant information was obtained from this source to assist with the investigation.

2.2 The grounding

No one on board *Desh Rakshak* observed that the ship had grounded on the morning of 4 January 2006. However, the evidence indicates that the ship probably grounded at about 0825, when it was almost abeam of Point Lonsdale, while transiting from sea to the Melbourne outer anchorage.

2.2.1 The rock found in the ship's lower fore peak tank

The Port of Melbourne Corporation commissioned the School of Earth Sciences at the University of Melbourne to carry out an analysis of the rock found in *Desh Rakshak*'s lower fore peak tank after the grounding. In summary, the report found that:

> The rock is a fine sand-size carbonate (85% $CaCO_3$) that is very well cemented by calcite. The calcite has a fibrous isopachous fabric, indicating it is of marine origin. The texture and composition of the sample are consistent with it being derived from the Bridgwater Formation, a Quaternary near-shore beach/barrier unit that is common along coastal regions in Victoria (and is the local rock type around the heads in Port Phillip Bay).
>
> The extensive marine borings on the surface of the sample indicate it has been within the marine environment for a considerable period of time. The marine fibrous cements in the sample also indicate a period of very extensive exposure to

sea water. The rock type is very similar to that found near the top of many marine cores from The Rip. This rock type is commonly found in either boulders lying on the sea floor, or within in-situ surface crusts on the sea floor.

2.2.2 The ship's track

While the pilot recalls all the visual cues that indicated to him, at the time, that the pilotage had gone according to his plan, an analysis of the VTS radar and AIS data shows that the ship was to the west of the pilot's intended track during the passage through the Port Phillip entrance (Figure 6).

The Port of Melbourne Corporation overlayed the data downloaded from the VTS radar and AIS systems onto a sea floor topographic map (Figure 7). The map indicates that the ship passed over areas of the sea floor with charted depths as low as 11.6 m. The tide measurement at Rip Bank at 0800 was 1.1 m; therefore the minimum depth of water the ship passed through was about 12.7 m.

The analysis of the rock found in *Desh Rakshak*'s lower fore peak tank, combined with an analysis of the ship's track and the likely under keel clearance at various times during the transit, indicate that the ship probably grounded in one or more of the shallower areas in the Western or Outer Western Ship Channels when it was almost abeam of Point Lonsdale.

2.3 Under keel clearance (UKC)

When the pilot calculated the ship's static UKC on the morning of 4 January he considered that the ship would be transiting the Great Ship Channel. The Great Ship Channel has a declared depth of 14 m, and the tide at 0800 was 1.1 m above chart datum. The minimum depth in the channel at 0800 was therefore 15.1 m. As the ship's static draught was 11.5 m, the pilot calculated its static UKC would be about 3.6 m. The pilot subsequently reassured the master that the ship's UKC would be at least 3.5 m at all times. The master did not question the pilot's calculations, nor did he make his own assessment or calculations to confirm the ship's UKC.

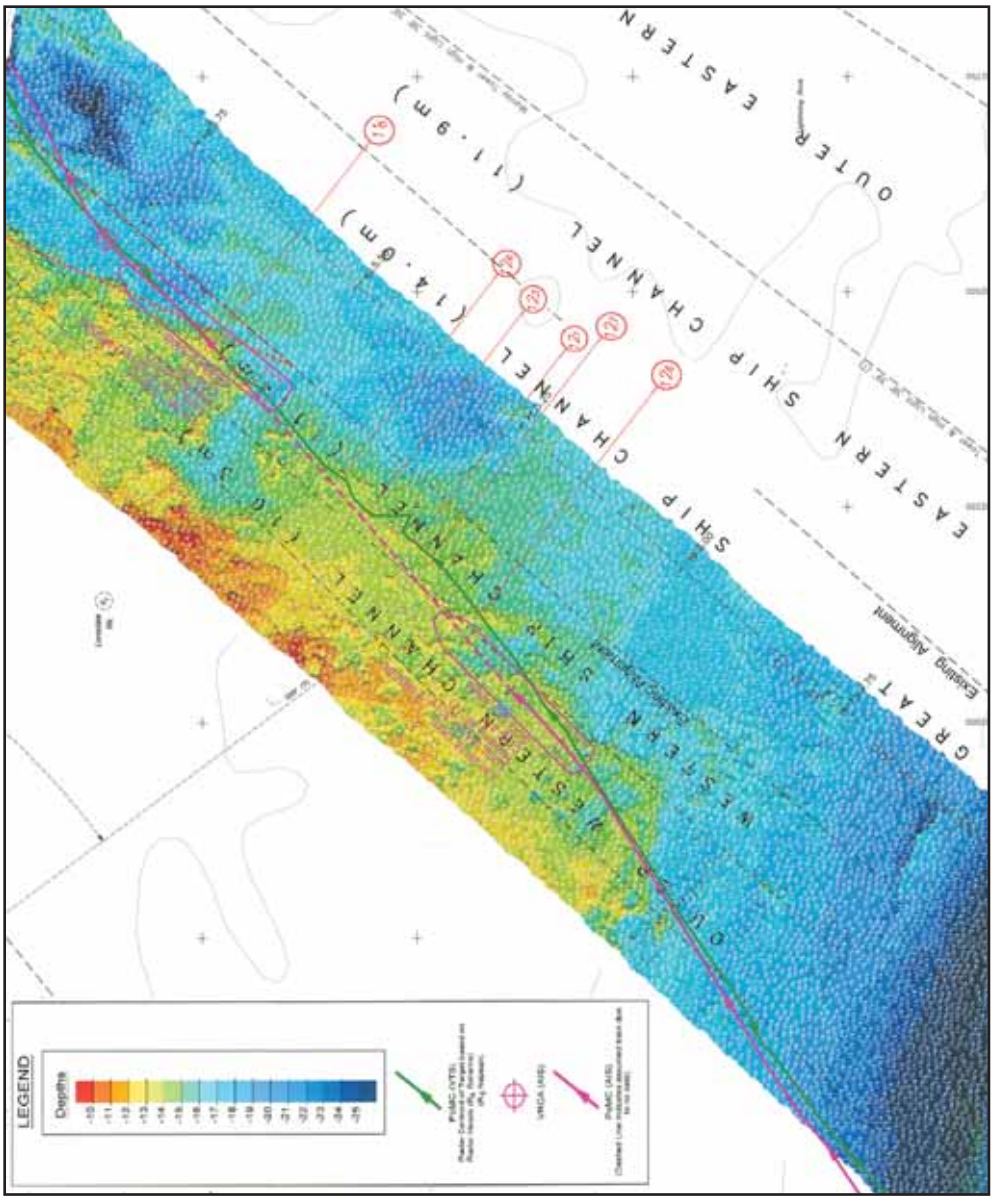
The pilot considered that a static UKC in excess of 3.5 m was sufficient, and thus made no further calculations. He did not consider that a combination of squat and the movement of the ship in the seaway would have the effect of considerably decreasing the ship's UKC during the transit.

2.3.1 Squat

Squat occurs as a ship moves into shallow water[6]. A venturi effect develops between the bottom of the hull and the seabed. The increase in velocity of the water flow under the hull causes a significant decrease in the hydrodynamic pressure acting upwards on the ship. This causes the ship to sink bodily until the upward hydrodynamic pressure and the downward force due to the mass of the ship are once again in equilibrium. The draught of the ship effectively increases and its trim may change, with the change in trim being dependent on the shape of the ship's hull.

6 Generally considered to be depths less than twice the ship's draught.

Figure 7: Extract from the Port Phillip entrance sea floor topographic map showing the area adjacent to Point Lonsdale with *Desh Rakshak's* track overlayed.



Squat is a well known phenomenon and has been a factor in a number of groundings. The most widely reported of these groundings was that of *Queen Elizabeth 2* in August 1992. *Queen Elizabeth 2* was crossing the Vineyard Sound off the coast of Massachusetts, USA at the time of the grounding. The ship was travelling at high speed, and the effect of squat was larger than had been anticipated.

The amount that a ship will squat increases in proportion to the square of its speed through the water and can be estimated by applying any one of a number of formulae. Barrass' formula[7] (see below) and a set of squat tables and guidelines relating to squat were contained in *Desh Rakshak*'s passage plan.

7 Dr C. B. Barrass developed this formula for ships in relatively shallow water but where there is no breadth restriction.

$$\text{Squat (m)} = Cb \times \frac{V^2}{100}$$

V = Speed of the ship through the water in knots

Cb = Block coefficient of the ship (approximately 0.8 for *Desh Rakshak*)

On 4 January 2006, the pilot on board *Desh Rakshak* did not think that squat was an issue, because by the time the ship was abeam of Point Lonsdale its speed was only eight knots over the ground. However, the amount a ship will squat is related to its apparent speed with respect to the water flow passing the hull, i.e. the ship's speed through the water. With the tide running at five to six knots against the ship, the ship's speed through the water at navigation full ahead would have been about 13 knots. The data in the ship's passage plan indicated that under these conditions the ship's draught would have increased by at least 1.35 m due to squat.

2.3.2 Movement in the seaway

Information contained in the ship's passage plan also indicates the increase in the ship's draught due to heel. During the transit of the port's entrance on 4 January *Desh Rakshak* was not heeling, but the ship was rolling slowly through about five degrees. The effect of a five degree roll on a ship's draught, when it reaches the limit of the roll, is the same as that of a five degree heel. A heel, or roll, of five degrees would have the effect of increasing the ship's maximum draught by about 1.8 m.

The effect that riding, or surfing, down waves would have on a ship's draught is difficult to estimate without precise wave data. It would however have had the effect of increasing the ship's draught to some extent.

The combination of these conditions and a strong tidal flow during the ship's transit of the Port Phillip entrance meant that the ship's maximum instantaneous draught was at least 14.65 m. While a maximum draught of 14.65 m may have allowed sufficient UKC for the planned transit of the Great Ship Channel with a tide height 1.1 m above chart datum, there was insufficient UKC for the ship's actual passage through the Western and Outer Western Channels, which had minimum depths of 12.5 m and 11.4 m respectively, at 0800 on 4 January.

In submission the pilot stated that:

> There are no recognised tables for allowance for pitching, rolling or heeling that can be applied for ships entering Port Phillip. Allowances for these have been arbitrarily applied in the past, but not scientifically. Each ship tends to behave differently in the prevailing conditions on the day. However, after many years of 11m+ draft vessels entering by the Great Ship Channel with adequate UKC, there has not been a touch-bottom incident attributed to pitch/roll or heel.

2.3.3 UKC monitoring

Desh Rakshak was fitted with a digital graphic display echo sounder. It indicated the depth below the transducer at any given time. The display showed a history of water depth over a short period of time. The transducer was fitted in the bow section of the ship, only recording the depth under this part of the ship. An echo sounder does not look forward or to either side and is therefore of little assistance in preventing

a grounding. It does, however, provide information that will indicate a shelving sea floor. It can also confirm expected depths and thus the ship's position during a passage through accurately surveyed pilotage waters. An echo sounder is therefore a useful monitoring tool.

The ship's echo sounder was fitted with an alarm, which had been set at two metres prior to the pilotage. It also had a recording trace facility, but this function was not turned on during the pilotage.

It was normal practice on board the ship for the duty mate or cadet to record the echo sounder readings. The time interval between echo sounder recordings varied but, between 0800 and 0830, the depth of water under the echo sounder transducer was recorded at about five minute intervals. A minimum water depth, under the transducer, of 4.6 m was recorded at 0825.

There were no comments or notations in the echo sounder book, or the deck log book relating to any echo sounder alarms. However, the cadet recalled the alarm activating on two or three occasions during the pilotage, but he could not remember when this occurred. He said that on each occasion he informed the master and the pilot, but neither the pilot nor the master recalled this happening.

If the recording trace had been operating during the pilotage, and adequately monitored by the bridge team, the trace may have given an indication of the topography of the sea floor the ship was traversing during its transit.

Had the pilot been informed that the sea floor was shelving when the ship was almost abeam of Point Lonsdale it is unlikely that he could have made a course alteration in time to prevent the ship grounding. Notwithstanding this, the recording of depths at five minute intervals was of no assistance to the safe navigation of the ship, it was merely a recording exercise.

2.4 Bridge resource management (BRM)

Nijjer, R. defines BRM as:

> The use and coordination of all the skills and resources available to the bridge team to achieve the established goal of optimum safety and efficiency.[8]

The Australian Maritime Safety Authority, Marine Notice No. 34/2002, states the following:

> BRM should begin at the initial pre-passage planning stage to identify the dangers to be met and the necessary precautions and contingency arrangements, and continue until the end of the passage. A debriefing should be held shortly after the passage to analyse the events and to identify improvements that can be made in the BRM arrangements for subsequent passages. BRM should include a clear identification of all the bridge team members at all stages of the voyage, their relative duties and responsibilities, and the line of command including the levels of authority in making, challenging or responding to decisions and instructions.

BRM provides a method of organising the best use of human and other resources on the bridge to reduce the level of operational risk. Adequate passage planning,

8 Nijjer, R. (2000) *Bridge Resource Management: The Missing Link*, Sea Australia 2000, Sydney.

the master/pilot information exchange and the bridge team briefing prior to a pilotage passage are critical elements of effective BRM, as they help to minimise the considerable risks associated with the operation. A key aspect of BRM is that it helps the bridge team build a 'shared mental model' and puts in place defences against 'single person errors' which can result in a serious casualty.

When the pilot arrived on the bridge on the morning of 4 January 2006, he and the master had a discussion about the pilot's plan for the passage. They did not include the officer of the watch in these discussions and they did not allocate defined responsibilities to individuals within the bridge team.

It was the pilot's expectation that the ship's crew would monitor the ship's position and UKC, but he did not ensure that these tasks were allocated to anyone. Furthermore, he did not set limits at which he should be challenged.

The master had allocated some tasks to the bridge team prior to the pilot boarding the ship. The master was to visually monitor the passage, the third mate was to check the ship's position and plot it on the chart, and the cadet was to record the echo sounder readings. However, no one knew when, or if, they should bring information to the attention of the pilot, or challenge his decisions. In effect, the ship's crew observed the pilotage, but they did not actively participate in it.

The evidence does not suggest that any member of the ship's bridge team was aware that the ship was to the west of where the pilot intended it to be. However, had they been more fully briefed, and fully understood the pilot's plan for the passage, they would have been better placed to assist him.

2.5 The pilotage

Traditionally, a pilot is engaged by the ship's owner as a specialist advisor and ship handler. The pilot advises the master on the conduct of the ship in waters in which the pilot has local knowledge of tides, conditions, channels and port operations. The master maintains overall command and responsibility for the ship, while the pilot has the navigational control of the ship.

Pilots, pilot associations, port authorities and government authorities increasingly see the role of pilotage as a port function. Its principal purposes being safety and the reduction, to the greatest extent possible, of the structural, environmental and financial risks associated with ships navigating within the port and its limits.

All pilotage services in Port Phillip are provided by a private company. The pilots are licensed by Marine Safety Victoria and operate with safety oversight provided by the Port of Melbourne Corporation. Pilots are required to operate in accordance with the harbour master's directions and the Port of Melbourne Operating Handbook.

The harbour master's directions included the following advice in relation to entering Port Philip during ebb tides.

> As the ebb stream at times attains a speed of nine knots, low powered vessels will best transit through the Heads around the times of slack water.

On the morning of 4 January 2006, the pilot was aware of the difficulties that he may encounter piloting *Desh Rakshak* through the Port Phillip entrance, due to the strength of the ebbing tide. He could have delayed the ship's transit to a time when the ebb tide would not have been such a significant factor in the pilotage. However, after considering the prevailing conditions, he thought it was possible to safely pilot the ship from sea to the Melbourne outer anchorage.

The pilot chose to board the ship further out to sea than his normal boarding location and at a higher than normal boarding speed. As soon as he boarded the ship he asked the master to increase main engine revolutions to navigation full ahead. All of these actions were aimed at ensuring that the ship had built up to its maximum speed before it reached the port's entrance and was subject to the full effect of the ebb tide.

Furthermore, the pilot formulated a passage plan that would keep the ship to the west of the track marked by the Queenscliff high and low leading lights, keeping it out of the main tidal flow for as long as possible. He expected that by the time the ship was abeam of Point Lonsdale, the ebb tide would have pushed it to the east and into the Great Ship Channel. If the pilot had executed his plan as intended, it is likely that the ship would not have grounded.

The pilot could have boarded the ship further to sea or taken the ship through a round turn before entering the port. Either of these options would have assisted the pilot in ensuring the ship was at navigation full ahead at the start of its transit of the port's entrance, and given him more time in which to complete the master/pilot information exchange and to prepare the bridge team for the pilotage. However, both actions would have delayed the ship's entry into the port. The ship would have then been transiting the entrance at a time when the ebb tide would have been even stronger.

The pilotage company had procedures relating to entering Port Phillip in their pilotage notes and a standard passage plan was provided to pilots for use during all passages. However, there was no formal process of assessing if it was appropriate for *Desh Rakshak* to undertake a passage through the Port Phillip entrance in the prevailing conditions. The decision whether to pilot the ship, or not, was left entirely in the hands of the pilot. The pilotage company was relying entirely on the pilot's training, experience and judgement.

The port authority and pilotage company had not adequately addressed the risks associated with piloting a loaded tanker through the Port Phillip entrance during a strong ebb tide. The pilotage company had not identified the need to have effective guidelines and procedures and in place to provide sufficient direction and guidance to the pilot when making the decision whether to, or indeed how to, pilot *Desh Rakshak* from sea to the Melbourne outer anchorage in the prevailing conditions.

2.5.1 The pilot boarding ground

At the time of this incident the Port Phillip pilot boarding ground was located 3.3 miles southwest of Point Lonsdale Lighthouse (Figure 4). However, on 4 January 2006, the pilot chose to board *Desh Rakshak* when the ship was four miles

southwest of Point Lonsdale. This was further to seaward than where he would normally board a ship.

Traditionally the location of a port's pilot boarding ground near its entrance or fairway has been determined by operational needs and:

- is outside the port limits but in close proximity to the port;
- allows for safe pilot transfer;
- positions the ship for the pilotage passage ahead; and
- is suitable for the types of ships using the port.

While these operational needs are important, the pilot's principal role is the reduction of the risks associated with ships navigating within the port and its limits. In this context there are new operational needs that should be considered when determining the location of a port's pilot boarding ground. It is not enough to simply instruct a pilot to implement a range of risk minimising strategies, such as BRM. The pilot has to be afforded the time necessary to fully implement these strategies if they are to be effective.

The pilot stated that it was difficult for him to discuss the passage plan with the entire bridge team and implement all aspects of BRM in the limited time available between when he boarded *Desh Rakshak* and when the ship entered the port. He felt that he had far more pressing tasks to attend to; getting the ship up to speed, monitoring its heading in preparation for the pilotage passage and communicating with VTS.

Risk minimising strategies such as BRM were not considered necessary as little as a couple of decades ago and, consequently, were not a consideration when the location of the pilot boarding ground was chosen. However, the implementation of BRM on board *Desh Rakshak* prior to the start of its pilotage passage on 4 January 2006 may well have helped to prevent the grounding.

The time available for the pilot to implement risk minimising strategies, such as BRM, is directly linked to the distance the ship travels between the position at which the pilot boards the ship and the port's entrance. Therefore, a regular review of the port's pilot boarding ground, with particular reference to changes in procedures, practices and expectations is important.

3 FINDINGS

From the evidence available, the following findings are made with respect to the grounding of *Desh Rakshak* on 4 January 2006 during its transit of the entrance to Port Phillip and should not be read as apportioning blame or liability to any particular organisation or individual.

3.1 Contributing safety factors

1. Neither the pilot nor the ship's crew adequately considered the ship's speed through the water, or its movement in the prevailing conditions, and consequently the ship's under keel clearance was less than had been anticipated.
2. Port Phillip Sea Pilots procedures and guidelines did not give effective guidance or assistance to the pilot when deciding whether to pilot the ship from sea to the Melbourne outer anchorage in the prevailing conditions.
3. The inadequate application of bridge resource management principles, due in part to the lack of time available between when the pilot boarded the ship and when it entered the port, led to the ship's bridge team having little effective input during the pilotage passage.

3.2 Other key findings

1. *Desh Rakshak* probably grounded in one or more of the shallower areas in the Western or Outer Western Ship Channels at about 0825, when the ship was almost abeam of Point Lonsdale.
2. The bridge team did not effectively use the echo sounder to monitor the depth of water under the ship's bow.

4 SAFETY ACTIONS

4.1 Safety action by Port of Melbourne Corporation

The ATSB has been advised that the following safety action has been taken as a result of the grounding of *Desh Rakshak*.

1. Notice to Mariners No. 38/06 was published by the Port of Melbourne Corporation on 16 March 2006. The notice included the following changes to the definition of the pilot boarding ground.

   "Pilot Boarding Ground means those bodies of water defined as -

   a) Inner Pilot Boarding Ground located 3 nautical miles southwest of Point Lonsdale; and

   b) Outer Pilot Boarding Ground located 5 nautical miles southwest of Point Lonsdale."

4.2 Safety action by Port Phillip Sea Pilots

The ATSB has been advised that the following safety action has been taken as a result of the grounding of *Desh Rakshak*.

1. A review of procedures and practices was instigated prior to the grounding of *Desh Rakshak*, with consultants tasked to review the company's safety management system. This review was still ongoing at the time of this report was published.
2. Each pilot is being provided with a laptop computer, loaded with the latest electronic charts and company approved standard courses, which is to be carried on board for each pilotage act. Pilots will also receive training in the use of these units.
3. All expected transits of deep draught tankers and other low powered vessels are to be checked by the pilot in charge to determine if a passage through the 'Heads' is safe given the vessel's estimated time of arrival. If it is deemed to be unsuitable, the vessel's master or agent will be advised of an appropriate transit window. The allocated pilot will also check these decisions prior to boarding.

4.3 ATSB recommendations

MR20070009

Port Phillip Sea Pilots should review their training, procedures and practices to ensure that pilots implement all aspects of bridge resource management, to ensure that all bridge team members are aware of their responsibilities, and how the pilot expects the bridge team to interact.

MR20070010

Port Phillip Sea Pilots should review their procedures and practices to ensure that pilots board ships at a location that ensures sufficient time is available for the pilot to adequately brief the crew before the ship reaches the port's entrance.

MR20070011

Port Phillip Sea Pilots should review their procedures and practices to ensure that squat and the ship's movement in the prevailing conditions are adequately considered when it's under keel clearance is calculated.

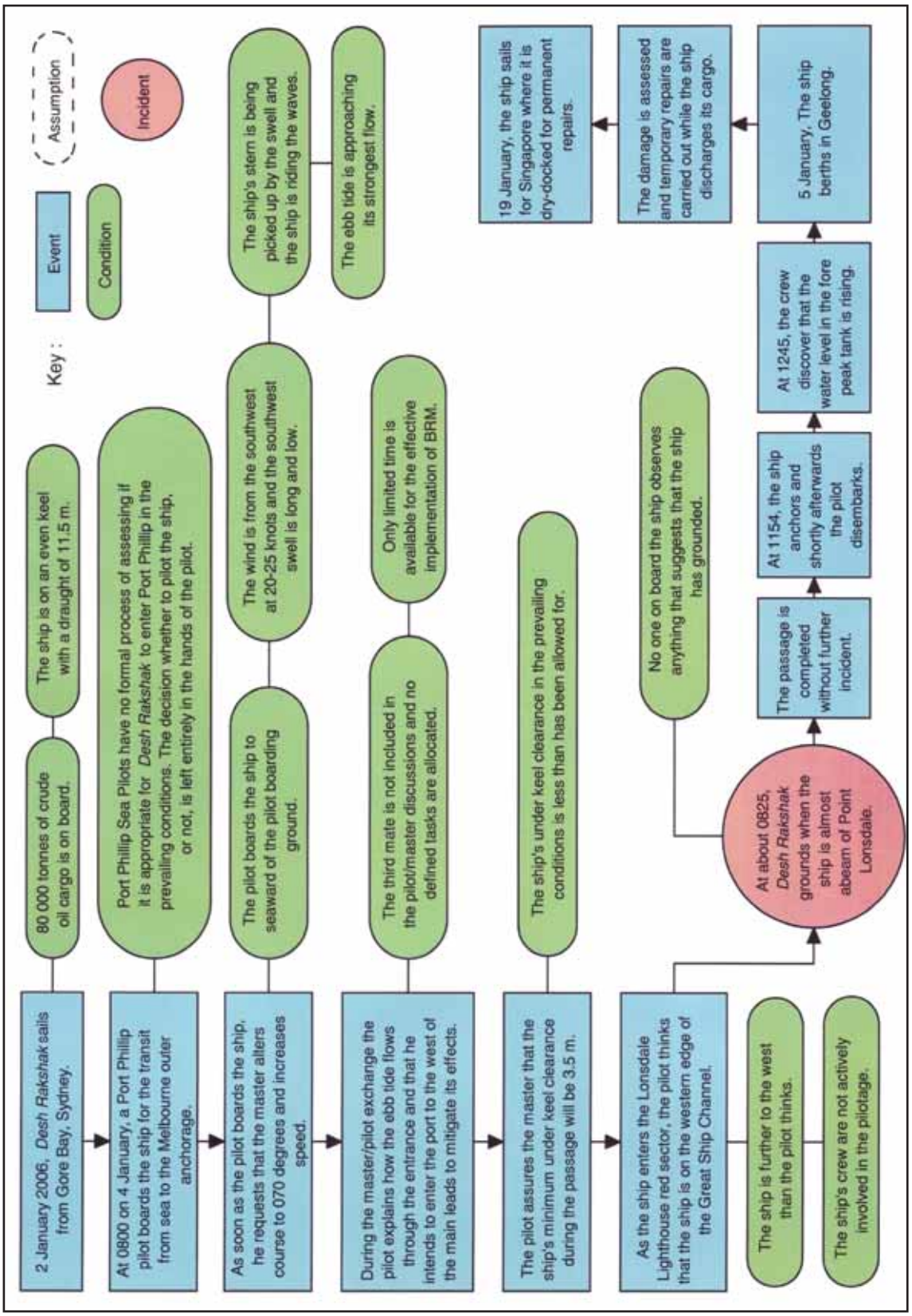
MR20070012

The Shipping Corporation of India should review their training, procedures and practices to ensure that all aspects of bridge resource management are implemented on board their ships; and that all bridge team members are aware of their responsibilities, and how they are expected to interact with a pilot.

MR20070013

The Shipping Corporation of India should review the procedures and practices on board their ships in relation to the use and monitoring of echo sounders.

5 APPENDIX A: EVENTS AND CONDITIONS



6 APPENDIX B: SHIP INFORMATION

6.1 *Desh Rakshak*

IMO Number	9243021
Call sign	AUBE
Flag	India
Port of Registry	Mumbai
Classification society	American Bureau of Shipping
Ship Type	Oil tanker
Builder	Hyundai Heavy Industries
Year built	2003
Owners / managers	The Shipping Corporation of India
Gross tonnage	61 978
Net tonnage	35 539
Deadweight (summer)	114 600 tonnes
Summer draught	13.60 m
Length overall	244.16 m
Length between perpendiculars	234.00 m
Moulded breadth	42.00 m
Moulded depth	22.60 m
Engine	B&W 6S60MC
Total power	10 765 kW
Crew	40

7 APPENDIX C: SOURCES AND SUBMISSIONS

7.1 Sources of information

The master and crew of *Desh Rakshak*

The Pilot

Port Phillip Sea Pilots

The Port of Melbourne Corporation

The American Bureau of Shipping

7.2 References

Australian Maritime Safety Authority Marine Notice No. 34/2002

Australia Pilot Volume II (NP14), HM Hydrographic Office, Seventh Edition 1992.

R Nijjer, *Bridge Resource Management: The Missing Link*, Sea Australia, Sydney, 2000.

The International Convention for the Safety of Life at Sea, 1974, and its Protocol of 1988 (SOLAS), the International Maritime Organization.

7.3 Submissions

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

The final draft of this report was sent to *Desh Rakshak*'s master and ship manager; the pilot, Port Phillip Sea Pilots, the Port of Melbourne Corporation, the Australian Maritime Safety Authority and the Indian Directorate General of Shipping.

Submissions were received from the pilot, Port Phillip Sea Pilots and the Port of Melbourne Corporation. The submissions have been included and/or the text of the report was amended where appropriate.

8 APPENDIX D: MEDIA RELEASE

Grounding of oil tanker in the entrance to Port Phillip

The ATSB has found that neither the harbour pilot nor the ship's crew adequately considered the ship's speed or its movement in the prevailing conditions and this led to the Indian oil tanker *Desh Rakshak* grounding near Point Lonsdale.

The Australian Transport Safety Bureau investigation found that the depth of water below the ship's keel was less than the bridge team had anticipated; and the Port Phillip Sea Pilots' procedures did not give effective guidance to the pilot when deciding whether, or not, to pilot the ship from sea to the Melbourne outer anchorage in the prevailing conditions. It was also found that the inadequate application of bridge resource management led to the ship's bridge team having little effective input during the pilotage passage.

Desh Rakshak arrived off Port Phillip on the morning of 4 January 2006, with about 80 000 tonnes of crude oil cargo on board, and at 0800 a pilot boarded the ship for the transit from sea to the Melbourne outer anchorage.

The pilot planned to enter the port to the west of the track marked by the main leading lights, to keep the ship out of an opposing tidal flow for as long as possible. When the ship was almost abeam of Point Lonsdale Lighthouse, the pilot thought he could see the high and low main leading lights just open to the west. This indicated to him that the ship was on the edge of the Great Ship Channel. However, the ship was further to the west than the pilot thought.

The ship continued the transit and anchored at 1154. No one on board the ship observed anything that might have suggested that the ship had grounded at about 0825, when it was abeam of Point Lonsdale.

At about 1245, the ship's crew discovered that the level in the lower fore peak water ballast tank was rising. An inspection of the tank revealed that the ship's hull had been holed.

The ship berthed in Geelong on 5 January and temporary repairs were carried out before it sailed for Singapore on 19 January, where it was dry-docked for permanent repairs.

The ATSB is pleased to report safety action already taken and has made several safety recommendations with the aim of preventing similar events.

Independent investigation into the grounding of the Indian registered oil tanker *Desh Rakshak* in the entrance to Port Phillip, Victoria on 4 January 2006.