Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT

Marine Occurrence Investigation No. 227

Final

Independent investigation into the grounding of the Singapore registered woodchip carrier

Crimson Mars

in the River Tamar, Tasmania

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Published by:	Australian Transport Safety Bureau
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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Independent investigation into the grounding of the Singapore registered woodchip carrier *Crimson Mars* in the River Tamar, Tasmania on 1 May 2006

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Australian Transport Safety Bureau
PO Box 967, Civic Square ACT 2608 Australia
www.atsb.gov.au

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Photographs of *Crimson Mars* are courtesy of Sandigan Ship Services and Tasmanian Port Corporation (TasPorts).

Abstract

At 1400 on 1 May 2006, *Crimson Mars* sailed from Bell Bay, northern Tasmania with a local pilot on board. The sky was cloudy and the visibility was clear with a light south-easterly wind. During the ship's turn to port around Garden Island, at about 1440, starboard instead of port helm was applied for approximately one minute. The error was not noticed initially and by the time maximum port helm was applied at 1441, grounding was inevitable. Soon after, the pilot ordered both anchors to be let go and the main engine to be run at emergency full astern in an attempt to reduce the effects of the impact. At 1442, the ship grounded on Long Tom Reef as the port anchor was let go and the main engine run astern.

The ship, with its main engine running astern, moved off the reef and refloated at 1446. An attempt to retrieve the anchor resulted in the failure of the port windlass. The ship remained anchored until 1605 when two tugs arrived to assist. The anchor cable was cut and left in the river with the port anchor. The ship then returned to the Bell Bay anchorage with the assistance of the tugs.

An inspection of the ship revealed that it was severely damaged and that temporary repairs could not be carried out in Bell Bay. The ship's departure was delayed until contingency arrangements could be put in place. *Crimson Mars* sailed from Bell Bay on 12 May for Hualien, Taiwan, to discharge its cargo and carry out permanent repairs.

The report identifies several safety 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

At 1400 on 1 May 2006, *Crimson Mars* sailed, nearly fully loaded, from Bell Bay with a local pilot on board. The sky was cloudy, visibility was clear with a light south-easterly wind and the tide was flooding. At 1421, the ship's main engine speed was increased and this gave the ship a speed of 10 knots over the ground. The helmsman was steering the ship as instructed by the pilot. The master and third mate were also on the ship's bridge for the pilotage passage.

The passage progressed as intended until about 1440 when a turn to port around Garden Island was being executed. During the turn, starboard instead of port helm was applied for approximately one minute and a turn to starboard developed. By the time maximum port helm was applied at 1441, the grounding of the ship was inevitable. Soon after, the pilot ordered both anchors to be let go and the main engine to be run at emergency full astern in an attempt to reduce the effects of the impact. At 1442, *Crimson Mars* grounded on Long Tom Reef and shuddered to a stop as the port anchor was let go and the main engine was run astern.

At 1446, the ship with its main engine running astern, moved off the reef and refloated. The pilot ordered the anchor to be retrieved. This resulted in the failure of the port windlass and the anchor cable running out to its bitter end[1], which held. The ship remained at anchor off Garden Island until two tugs that had been called to assist were made fast at 1605. The anchor cable was then cut, just above the hawse pipe, by the ship's crew using gas cutting equipment and left in the river together with the port anchor. The ship returned to the Bell Bay anchorage so that the extent of any damage could be assessed.

Crimson Mars was detained by the Australian Maritime Safety Authority (AMSA) on 2 May after a diver and the ship's crew conducted a preliminary assessment of the damage. The ship's bulbous bow had been pushed in leaving a hole about six metres wide and three metres high in the forepeak tank. There was also damage along the starboard side of the hull and number one starboard double bottom water ballast tank was holed. Further assessment by AMSA, in consultation with the Flag State and the classification society followed, with contingency arrangements agreed upon over the next few days.

The ship was released from detention on 10 May and sailed from Bell Bay on 12 May with the agreed arrangements in place. *Crimson Mars* was permitted a single voyage to Taiwan to discharge its cargo and then to undergo permanent repairs. The ship arrived in Taiwan on 3 June.

The investigation found that the use of starboard instead of port helm at about 1440, during the ship's turn off Garden Island, led directly to the grounding. It was also found that the pilot's unsuitable position for piloting the ship, the failure to monitor helm orders and their execution, ineffective bridge resource management and the distraction caused by the pilot's use of a mobile telephone may have contributed to the grounding.

1 The inboard end of the anchor cable that is secured to a strong point.

It is also considered that the indicative diagram in the port's passage plan did not include sufficient information to assist with the preparation of the ship's passage plan. The ship's and the port's procedures for contingency planning and emergency response, and the risk assessment by the master and the pilot after the grounding, were also considered to be inadequate. This resulted in the unnecessarily hazardous operations involved in retrieving the anchor and cutting the anchor cable.

The report recommends that:

- Pilots and masters should ensure that they are able to read, or otherwise be able to check, the rudder angle when conning a ship. They should also ensure that the conventions governing helm orders are observed, particularly the use of 'midships' when changing rudder direction, and 'closing the loop' when communicating orders to a helmsman. The use of hand signals to enhance the communication of helm orders should also be considered.
- TasPorts should consider reviewing their procedures with respect to contingency planning with a view to providing pilots with adequate support aimed at preventing groundings and ensuring that a pilot's response to grounding is effective and helps to mitigate the potential adverse consequences.
- TasPorts should review their procedures to ensure that the use of mobile telephones by pilots, if at all permitted, does not interfere with the safe navigation of ships in pilotage areas.
- TasPorts should consider revising the standard passage plan for Bell Bay, and its means of dissemination, to make it possible for ship's masters and mates to use it when preparing ship's passage plans.
- ClassNK should review the conning positions identified on *Crimson Mars*, and other similar ships, with a view to ensuring that rudder angle indicators are readable from all conning positions.
- The managers of *Crimson Mars* should review their safety management system with a view to ensuring that any response by ship's crews to an emergency is effective and safe.

1 FACTUAL INFORMATION

1.1 *Crimson Mars*

Crimson Mars is a Singapore registered 'woodchip carrier'[2] (Figure 1). The ship is owned by Lily Virgo, Singapore, managed by Sandigan Ship Services, Philippines, and chartered and operated by Nippon Yusen Kaisha (NYK Line), Japan.

Crimson Mars was built in 2002 by Shin Kurushima Dockyard Company, Ehime, Japan and classed with Nippon Kaiji Kyokai (ClassNK). The ship has an overall length of 199.99 m, a moulded breadth of 32.20 m and a moulded depth of 22.75 m. At a summer draught of 11.527 m, it has a deadweight of 49 917 tonnes.

The ship has six cargo holds, four cargo loading hoppers and three deck cranes, all located forward of the accommodation superstructure. It has a flush deck forecastle where the windlasses for the port and starboard anchors are located. Each anchor is fitted with 11 shackles[3] of chain cable.

Propulsive power is provided by a Mitsubishi Type 6UEC52LS diesel engine developing 7545 kW. The main engine drives a single, fixed pitch propeller which gives the ship a service speed of 14.1 knots[4].

Figure 1: *Crimson Mars* anchored in Bell Bay

Crimson Mars is equipped with navigational equipment consistent with SOLAS[5] requirements. This includes a Tokimec TG 6000 gyro compass with steering stand, a Tokimec course recorder and two Tokimec radars, an x-band BR 3440MA-X29 and an s-band BR 3440MA-S314. Two differential global positioning system (DGPS) receivers, a JRC JLR-7700 Mk II and a Furuno GP-80 are fitted adjacent to the chart

2 A cargo ship designed to carry woodchips in bulk.

3 One shackle is a standard length of anchor cable 90 feet (27.43 m) long.

4 A measure for speed in nautical miles per hour which is equal to 1.852 km per hour.

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

table which incorporates a Yokogawa SPL 2000 chart plotter. Other equipment includes a Furuno FA-150 automatic identification system (AIS) unit.

At the time of the incident, *Crimson Mars* had a crew of 22 Filipino nationals including the master. The deck department included three mates, a boatswain, three able seamen, two ordinary seamen and a deck cadet.

The master started his seagoing career as an apprentice mate in 1969 after graduating from a maritime college in the Philippines. He was first promoted to master in 1987 and had held that rank ever since. He had been in command of *Crimson Mars* for about six months and this was his second voyage to Bell Bay on the ship. It was his first assignment with the ship's managers.

The chief mate, who was on the forecastle at the time of the incident, had been on board the ship for seven months. He had obtained his qualifications as chief mate in 2002 in the Philippines. He had started his seagoing career with the ship's managers as a deck cadet and had eight years experience at sea.

The third mate, the officer of the watch at the time of the incident, had nine months experience as third mate, all of it on *Crimson Mars*. He had obtained his qualifications as third mate in 2001 in the Philippines. He started his seagoing career with the ship's managers as a deck cadet and had been an able seaman (AB) for two years prior to joining *Crimson Mars*.

The helmsman at the time of the incident had also been on the ship for nine months, his first assignment as an AB. He had completed his maritime training in 2001 in the Philippines, and had two years experience at sea. He had steered the ship many times before but not in the port of Bell Bay. He also had some steering experience on other ships before being promoted to AB.

1.1.1 Bridge layout

Crimson Mars's navigation bridge is about 11 metres wide (Figure 2). The rudder angle indicator inside the bridge was mounted above the bridge front window close to the centreline, next to the main engine tachometer. Directly below these instruments, under the bridge front window, a gyro compass repeater was mounted next to a sign indicating a conning position.

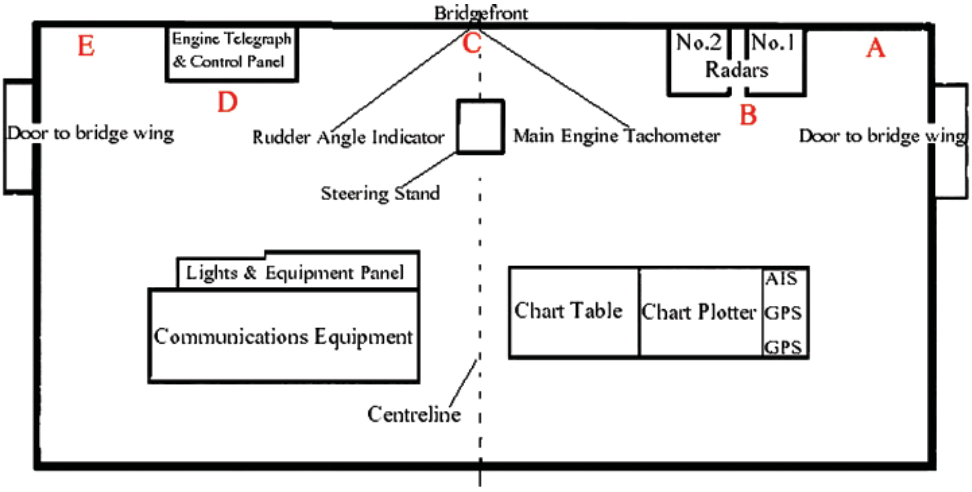
A conning position is defined as:

> … a place on the bridge with a commanding view and which is used by navigators when commanding, manoeuvring and controlling a ship[6].

ClassNK rules also specify the requirements with regard to the view of the sea surface from a conning position. When the conning position is located on the centreline and obstructions like masts or cranes obscure the view, ClassNK rules require at least two additional conning positions. These positions must be located on opposite sides of the bridge and within five metres of the centreline conning position.

6 Rules for the survey and construction of steel ships, Part W, Navigation Bridge Visibility, ClassNK.

Figure 2: ***Crimson Mars*****'s bridge layout with details relevant to the incident**



Crimson Mars's general arrangement (GA) plan identified a 'conning position' on the centreline inside the bridge (position C in Figure 2), and because the view forward from this position was obscured by the cranes, two 'additional conning positions' (A and E) 4.80 m on either side of the centreline. Each position was about 0.30 m aft of the bridge front and all three were prominently indicated by identical signs with the words 'CONNING PT.' painted in red on the bridge front. The rudder angle indicator was clearly readable from the centreline conning position, but could not be read from either additional conning position.

1.2 Bell Bay

Bell Bay is the name generally used for Port Dalrymple on the banks of the River Tamar in northern Tasmania (Figure 3). It is a busy port located near a major industrial centre. A number of cargoes both to and from interstate and overseas destinations, including woodchips for export, are handled in the port.

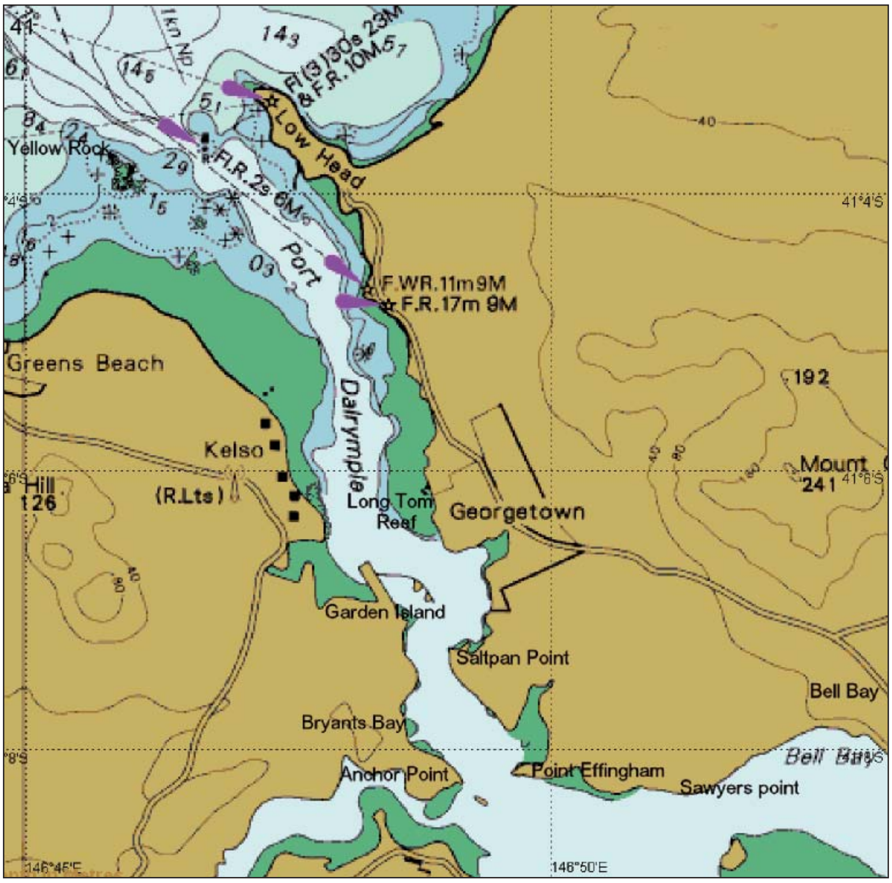
The Tasmanian Port Corporation (TasPorts) manages Bell Bay in addition to other major ports in Tasmania. It is also responsible for the provision of pilotage services in these ports. Pilotage in Bell Bay is compulsory for all ships of 35 m or more in length, unless an applicable pilotage exemption certificate is held by the ship's master.

The port lies about eight miles[7] from the river entrance. The pilot boarding ground is a further three miles to seaward making the pilotage passage about 11 miles. The channel along the river, particularly north of Bryants Bay, is narrow with numerous changes in direction and is marked with beacons northwards from Georgetown. Tidal flows have a significant effect on ships navigating the river including the area off Garden Island. The minimum channel width is one cable[8] and pilots calculate a ship's static under-keel clearance based on a minimum channel depth of 10.40 m.

7 One mile refers to one nautical mile.

8 One cable is one tenth of a nautical mile.

Figure 3: Section of the navigational chart Aus 167 from Bell Bay to Low Head



1.2.1 The pilot

The pilot started his seagoing career as an apprentice in 1969 and obtained qualifications as a master mariner in 1985. He sailed as master from 1990 until he started training as a Bell Bay pilot in 1993. He has been a pilot at the port ever since.

At the time that the pilot trained, the general policy on pilot training at Bell Bay required 100 voyages under supervision. This was usually completed by a trainee in about one year and consisted of an initial period as an observer, followed by piloting under the supervision of a fully qualified pilot. Upon satisfactory completion of the training, a pilot was permitted to independently pilot ships, at the discretion of the general manager for port services, where the pilotage was considered less difficult (smaller ships and/or daylight pilotage). After a further year of experience a pilot could be assigned any pilotage in the port, but there was no formal system of restrictions or grades for a pilot's licence.

The pilot had completed bridge resource management (BRM) training in 1997. Bell Bay pilots also undergo annual refresher training for piloting in restricted visibility on the radar simulator at the Australian Maritime College (AMC), Launceston. Other training sessions are arranged on the ship simulator at the AMC, if required, to simulate ships which may have different handling characteristics to those usually piloted. Each pilot's performance is audited annually by another pilot, during a pilotage, and this is recorded.

1.3 The incident

At 0405[9] on 1 May 2006, *Crimson Mars* completed loading a cargo of 45 929 tonnes of woodchips while alongside berth number six at Bell Bay. The pilot boarded the ship at 1310. A draught survey, required to calculate the cargo loaded by the ship, was then performed by the pilot. The ship was loaded close to its summer marks, nearly on an even keel, with draughts of 11.47 m forward and 11.49 m aft. After completing the survey at 1345, the pilot was escorted to the bridge by the third mate. By this time the ship's pre-departure bridge and engine room checks had been completed. The sky was cloudy and visibility was clear with a light south-easterly wind. The tide was flooding with high water at Georgetown predicted to occur at 1505.

After arriving on the bridge, the pilot discussed the departure plan with the master. He used the port's standard passage plan form during the master/pilot information exchange. The passage plan included checks for sighting the ship's pilot card, making fast the tugs, confirming the anchors were ready for emergencies, main engine and steering tested, two steering motors on, and the under-keel clearance calculations. After the exchange, the pilot instructed the helmsman to inform him if he had any doubts about any orders the pilot gave, or in the event of any steering malfunction, however minor.

At 1400, *Crimson Mars*'s last mooring lines were cast off. The two tugs assisting were released at 1412, after the ship was clear of the berth. This was according to plan, as the tugs were required for an inbound ship which was due to berth further up the river. *Crimson Mars*'s schedule also allowed it to pass the inbound ship in an area south of Bryants Bay as planned.

The pilot found *Crimson Mars* 'sluggish', like most other fully laden woodchip carriers on an even keel. The ship was slow to start a turn and slow to respond to the helm once turning, making it slightly more difficult to steady on a heading. The pilot estimated the tidal stream to be about two knots and this was reducing the ship's speed over the ground. To improve the steering by increasing the flow of water over the rudder, and increase the ship's speed over the ground, the pilot asked for 'navigation full ahead'[10] at about 1420 when the ship was off the eastern beacons of the Bell Bay channel. On 'sluggish' ships it is usual for the pilotage to be conducted at navigation full ahead revolutions provided the main engine is ready for immediate manoeuvring.

The master ordered navigation full ahead at 1421 and *Crimson Mars* proceeded along the river with the pilot conning the ship (Figure 4). The ship was in hand steering mode with the helmsman at the wheel. Control of the main engine was in the engine control room and the engineers were standing by to manoeuvre the engine as required.

After clearing the Bell Bay channel at about 1423, the pilot moved to the additional conning position on the starboard side of the bridge (position A in Figure 2). This allowed him a clearer view ahead and the use of the radar display to check the ship's

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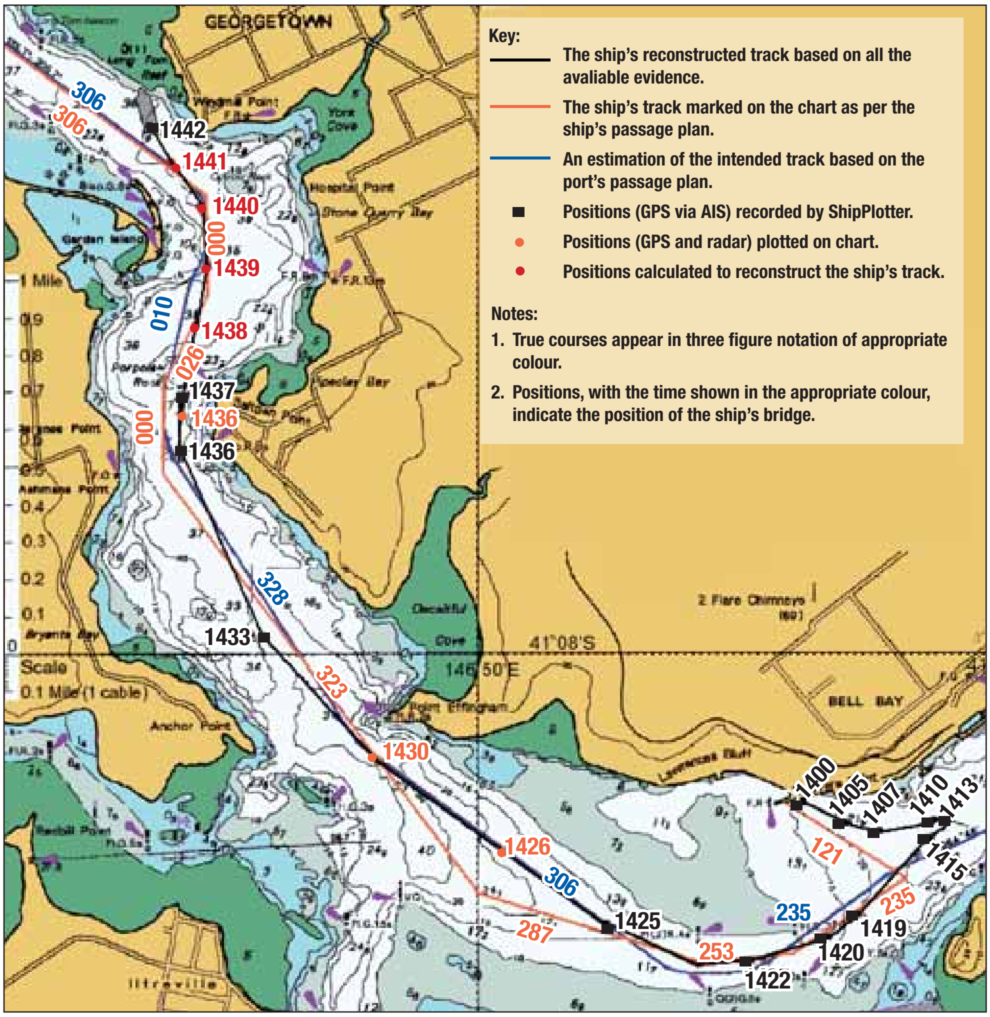
9 All times referred to in this report are local time, Coordinated Universal Time (UTC) + 10 hours.

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

course and speed. The third mate stood by the main engine telegraph, except when plotting positions on the chart. The master was continually moving from one side of the bridge to the other.

Figure 4: Track of *Crimson Mars* on 1 May



At 1433, the ship was off Bryants Bay heading towards the narrower parts of the river. Just before 1436, the pilot received a call on his mobile telephone. He completed the call soon after 1436, as the ship approached Saltpan Point. *Crimson Mars* passed Saltpan Point at 1437 and its speed was 9.9 knots. Being aware that the ship was east of the usual track; the pilot adjusted his next planned course of 010° True (T) to about 006° by gyro compass.

Just after 1438, the pilot started the ship's turn to port around Garden Island towards the next intended course of 306° (T), with an order for port rudder followed by several more helm orders to maintain the desired rate of turn to port. The turn was proceeding as planned, but when Long Tom beacon was fine on the port bow, the rate of turn to port slowed. To maintain the rate of turn, the pilot stated he ordered 'port 10' and that he heard the helmsman respond to this and subsequent helm orders. However, starboard helm was applied and the turn to port slowed further with the ship's rate of turn to port nearly stopping. The pilot thought that this was the influence of a stronger than usual flood tide on the ship's port bow. He stated that he then ordered 'port 20'.

The helmsman stated that the pilot ordered 'starboard 20' and that he executed this order. Soon after, at about 1440, the ship's head started to swing to starboard. Now concerned, the pilot stated he ordered 'hard-a-port'. The helmsman recalled this order being 'hard-a-starboard' and moved the wheel further to starboard. The pilot, moving towards the centre of the bridge, then saw the rudder angle indicator. The rudder was moving towards hard over, 35°, to starboard. He immediately yelled 'hard-a-port, not starboard'. The master, on the port side of the bridge, ran and grabbed the wheel, and turned it to port.

Crimson Mars continued to turn to starboard while approaching Long Tom Reef. At 1441, with the main engine still at navigation full ahead, the pilot realised that grounding was inevitable. To minimise the effects of the impact he ordered emergency full astern on the main engine and to let go both anchors. The main engine was ordered emergency full astern at 1441½. At 1442, on a heading of 353°, the ship grounded as the main engine started to run astern and the port anchor was let go. The impact was felt on the bridge as the ship shuddered to a stop. The GPS position at 1442 was 41°06.60' S, 146°48.83' E, just off Long Tom Reef.

The chief mate, standing by on the forecastle with three crew members, had noticed the ship swinging to starboard. He then received the master's order to let go the anchors. He first confirmed the order, and then released the windlass brake on the port anchor. Five shackles of cable ran out and stopped before the crew reapplied the windlass brake. The chief mate could hear the sound of air rushing out of the ventilators of the fore peak ballast tank.

At 1445, the pilot called the port control using his mobile telephone. He informed port control that the ship had grounded, and requested immediate tug assistance.

During this time, *Crimson Mars*'s main engine continued to run at emergency full astern and the ship started to move astern. Seeing that the ship was moving off the reef, the pilot ordered the port anchor to be retrieved. The chief mate engaged the port windlass to heave in the anchor cable, which was very heavily loaded and taut. Soon after, the hydraulic motor of the port windlass failed. The entire cable then ran out, uncontrolled, to the bitter end, which held. The main engine was stopped at 1448½.

With all 11 shackles of the port anchor cable now run out, the chief mate checked the bitter end inside the forecastle store and found its securing arrangement undamaged. The main engine was operated astern again after 1451 and a few minutes later the ship settled in a position about one cable east of Garden Island, riding to the port anchor.

Soundings of tanks revealed water ingress into the fore peak tank, and later into number one starboard double bottom water ballast tank. The ship developed a starboard list, but no egress of oil or any pollution occurred.

While waiting for the tugs, the pilot used the main engine and the rudder to keep *Crimson Mars* in its position off Garden Island, clear of the dangers close by. The pilot was concerned that the ship could be pushed onto Garrow Rock when the tide started to ebb. He suggested to the master that if it was not possible to retrieve the anchor, the anchor cable should be cut with gas cutting equipment after the tugs arrived.

While waiting for the tugs, the chief engineer and chief mate had the crew prepare oxy-acetylene gas cutting equipment. They also prepared a wire stopper to take the weight of the cable before it was released, and an anchor buoy for connecting to the cable to indicate its position after it was released.

The tug *York Cove* arrived at 1545 and the tug *Risdon Cove* at 1600 and by 1605 *Risdon Cove* was made fast aft and *York Cove* forward. Soon after, the chief engineer cut the anchor cable just above the hawse pipe and forward of the port chain cable stopper. As the weight of the anchor cable came on the wire stopper, the wire parted. The anchor cable then fell through the hawse pipe into the river. The port anchor and nearly all of its cable now lay in the river. The crew had not been able to connect the anchor buoy. No one was injured during the various anchor cable operations on the forecastle.

With the anchor cable now disconnected, the tugs assisted *Crimson Mars* to turn in the river off Garden Island. The ship then returned to Bell Bay, with the tugs in attendance, so that an assessment of the damage could be made. The ship anchored at 1710 using the starboard anchor. The pilot left the ship at 1730 and he observed that the ship was listing to starboard with the average draught forward at about 12.40 m.

1.3.1 The delayed departure

While at anchor, an underwater inspection by a diver revealed that the ship's bulbous bow had been pushed in leaving a hole about five to six metres wide and three metres high, giving it a 'mouth like' appearance. The diver could easily access the fore peak tank through the holed bow and found a substantial amount of material from the seabed deposited inside. Indentations and paint damage aft of the bulbous bow were also evident. The damage described in the diver's report is evident in photographs taken during the subsequent repairs in dry dock (Figures 5 and 6).

The Australian Maritime Safety Authority (AMSA) attended *Crimson Mars* at anchor, declared the ship unseaworthy, and detained it at 1845 on 2 May. Over the next few days AMSA, ClassNK and the Maritime and Port Authority of Singapore (MPA), the Flag State, corresponded extensively.

At 0600 on 5 May, *Crimson Mars* was once again berthed at Bell Bay berth number six. Divers and underwater repair personnel attended the ship and ClassNK assessed whether temporary repairs were possible. Further assessment and correspondence took place and by 8 May it was determined that temporary repairs were not possible.

On 9 May, AMSA and MPA agreed on contingency arrangements in consultation with ClassNK. The ship was allowed, subject to specified conditions, to make a single voyage to the discharge port of Hualien, Taiwan and undergo permanent repairs there not later than 5 July 2006.

Figure 5: The damaged bulbous bow seen from the port side

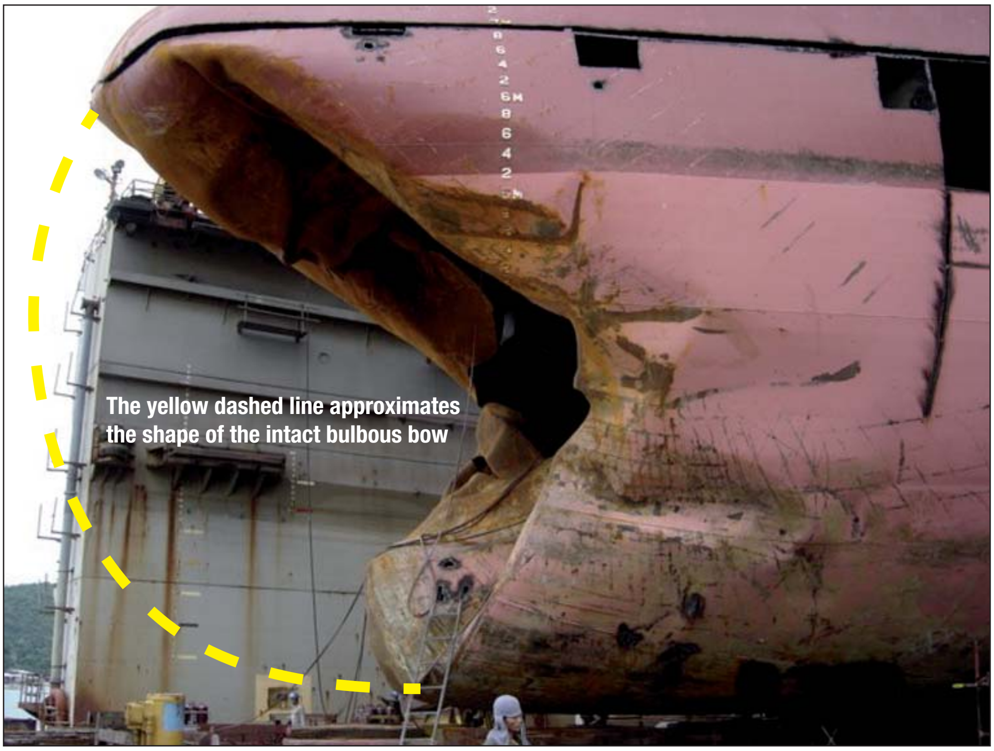


Figure 6: The holed bow and the damage down the starboard side

The conditions specified included:

- Restricting the cargo quantity in number one hold to 6850 tonnes.
- Keeping number one port double bottom water ballast tank empty.
- Reducing the navigational speed, preferably not exceeding eight knots.
- Monitoring water leakage into number one cargo hold and number one port double bottom water ballast tank during the voyage.
- Standing by the bilge and ballast pumping system for number one cargo hold and number one port and starboard water ballast tanks at all times.
- Using expert routing advice to ensure that weather conditions were considered when planning and executing the passage plan for the voyage to Taiwan.

At 1015 on 10 May, *Crimson Mars* was released from detention by AMSA after confirmation that the ship was aware of the specified conditions, verification that the ship was upright, trimmed appropriately, the load line was not submerged and that the water ingress into number one hold was being monitored. Strategies to prevent a recurrence of the incident were discussed by the regional AMSA surveyor and the master. The master provided a written response following these discussions.

The ship unloaded 767 tonnes of cargo from number one hold on 10 and 11 May. At 1000 on 12 May, the ship sailed from Bell Bay with draughts of 11.44 m forward and 11.47 m aft.

Crimson Mars arrived at Hualien, Taiwan on 3 June 2006 to discharge the remaining cargo before entering the dry dock to carry out permanent repairs.

2 ANALYSIS

2.1 Evidence

On 3 May 2006, two investigators from the Australian Transport Safety Bureau (ATSB) attended *Crimson Mars* at anchor in Bell Bay. The ship's master, chief mate, third mate and helmsman 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 main engine movement logger printout, passage plans, check lists, the master's statement of facts, standing orders and various procedures.

On 4 May, the investigators interviewed the pilot and obtained his report and copies of other documents at TasPorts' Bell Bay office. These documents included the automatic identification system (AIS) data printout from ShipPlotter[11], part of a system being trialled in the port. Each segment of AIS data recorded included the GPS position, heading, course and speed over ground. Due to the way the system sampled signals, data was recorded at random rather than specific times and intervals. Later that day, the investigators returned to *Crimson Mars* and obtained additional information.

The accuracy of the data recorded by equipment including the course recorder, main engine movement logger, AIS and ShipPlotter was checked by the investigators. Any inconsistencies found were resolved, and corrections applied to the data as appropriate. The various units, when checked, were operating as designed with no evidence to indicate that their accuracy or status was any different at the time of the incident.

Accounts of the incident provided during the interviews are the source of much of the information and are consistent with, and corroborate, other evidence. The ship was not fitted with a voyage data recorder or a voice recording device on the bridge.

During the course of the investigation other evidence including telephone records, classification society rules, details of the damage and photographs were obtained from various sources and are acknowledged in the report.

2.2 The grounding

The information from the course recorder, the ShipPlotter printout and the navigational chart was used to reconstruct *Crimson Mars*'s track on 1 May from the time of its departure at 1400 until the grounding at 1442, and is shown in black in figures 4 and 7.

The courses in the ship's passage plan were marked on a current and corrected edition of navigational chart Aus 167 that was used for the pilotage. The third mate had plotted positions on the chart recording the times as 1426, 1430 and 1436. These times were, in comparison to other evidence, one minute slow. The positions,

11 Computer software that decodes AIS signals received and records the data.

uncorrected for time and the ship's planned track are shown in orange in figures 4 and 7.

Other than the course recorder and the main engine movement logger, no recorded information was available for the five minutes preceding the grounding. The positions during this period, shown in red in figures 4 and 7, were calculated using the heading information from the course recorder and the AIS data at 1437 and 1442.

The evidence confirmed that the grounding occurred at 1442 and that the main engine ran at emergency full astern from about that time. The AIS data from ShipPlotter at 1442 recorded a course and speed over ground of 354° (T) at 7.4 knots and a GPS position of 41°06.60' S, 146°48.83' E. The ship's crew noted the grounding position as 41°06.5' S, 146°48.8' E on the chart. This minor inconsistency was probably because the crew recorded the minutes of latitude and longitude for all positions to one, instead of two decimal places. The crew may also have recorded the position at 1443 as the ship moved northwards and recorded the time as 1442, or one minute slow.

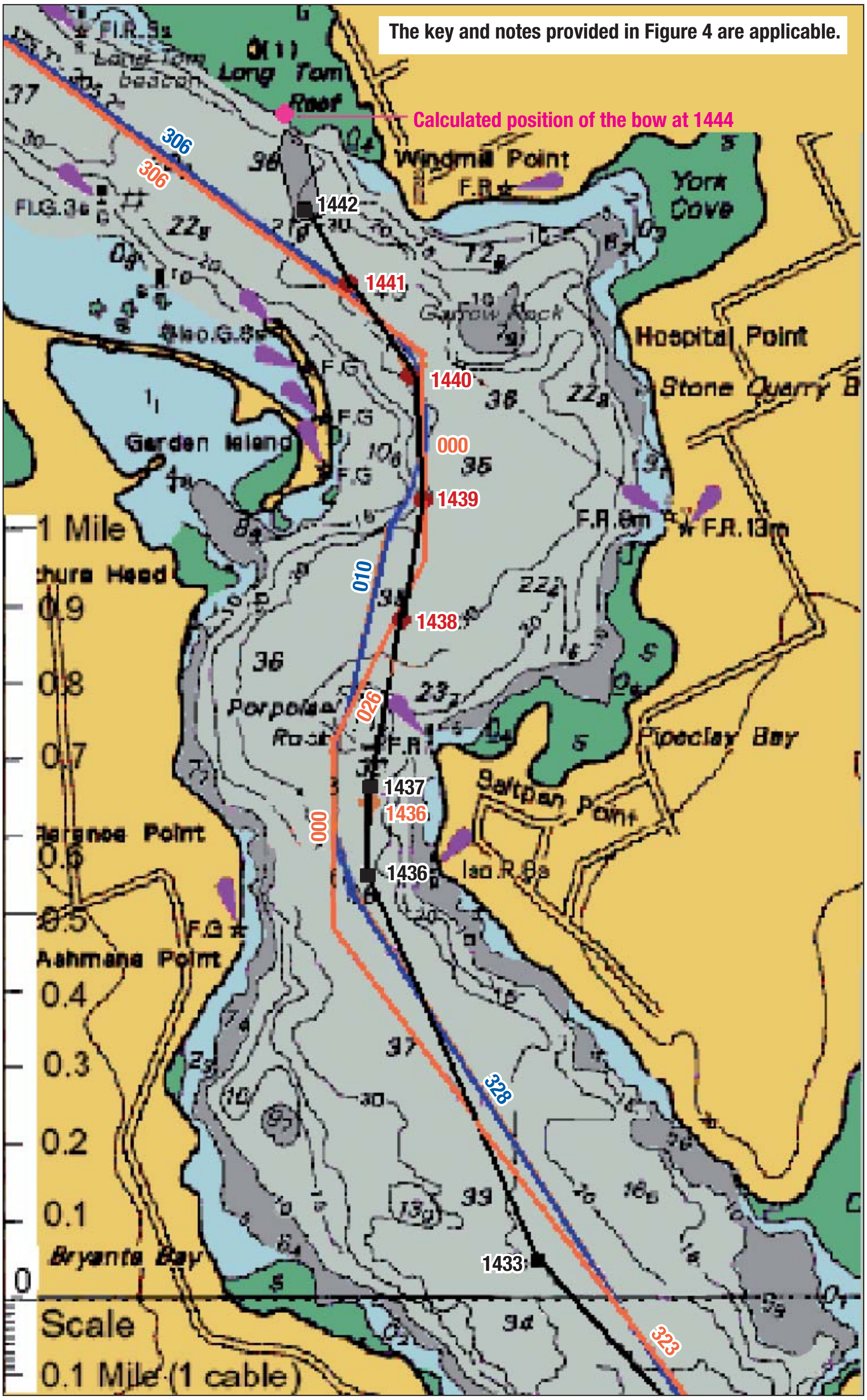
The ship's crew recorded that the port anchor was let go at 1445 but it is probable that this is not accurate as it is inconsistent with the chief mate's account of events. He heard the sound of air rushing out of the ventilators of the ruptured fore peak tank after the port anchor had been let go and five shackles of anchor cable had run out. It is likely that the anchor was let go at about the same time as the ship grounded.

The position at 1444 was the northernmost recorded and the calculated position of the bow at this time was the furthest extent of the ship's grounding on the reef (Figure 7). The ship then moved astern in a south-easterly direction and at 1444½ its speed was 1.8 knots with sternway increasing. The ship was afloat at 1446 and dragged the anchor until the windlass failed and the main engine was stopped at 1448½.

All the evidence indicates that the use starboard instead of port helm, during the ship's turn off Garden Island, led to the grounding. From about 1439½, starboard instead of port helm for each of three consecutive helm orders led directly and inevitably to the grounding. The pilot's and the helmsman's accounts of this succession of helm orders differ, but it is impossible to determine, with certainty, what the pilot's orders and the helmsman's verbal responses were. The master and the third mate did not confirm the account of either the pilot or the helmsman.

Using the available evidence it was possible to estimate the time that was available to avert the grounding after the initial use of incorrect helm. Had the first use of starboard helm at about 1439½ been corrected very quickly, the ship would probably not have run aground. If the use of increased starboard helm at about 1439¾ had been corrected immediately, the grounding may also have been averted. However, the use of further starboard helm at about 1440 made the grounding inevitable. There was, therefore, a period of no more than about 30 seconds available to the bridge team in which to take corrective action to avert the grounding.

Figure 7: *Crimson Mars*'s grounding on Long Tom Reef



2.2.1 Course recorder

The course recorder chart provided a continuous record of the ship's gyro compass heading plotted against time. Unlike some similar recorders, it did not record the rudder angle. It is possible, however, to estimate the rudder angles that were probably applied, and the times for these, based on the heading, the rate of turn derived from the course recorder trace, and the accounts of the pilot and the helmsman.

It is estimated that at about 1439½, 10 degrees of starboard rudder was applied. At about 1439¾, 20 degrees of starboard rudder was applied. Very soon after 1440, further starboard rudder was applied. By the time the wheel was turned to port, the rudder was probably close to hard over to starboard. *Crimson Mars*'s rudder would have taken about 25 seconds to move from hard over on one side to the other. Therefore the rudder was probably hard over to port at close to 1441.

The recorder chart (Figure 8) indicates that the pilotage progressed, as intended by the pilot, from the ship's departure at 1400 until about 1439½. An enlarged and expanded section of the course recorder chart provides the necessary detail for analysis (Figure 9). The recorder clock was in error and reading 30 seconds slow. All the times determined from the course recorder in this analysis have been corrected accordingly.

At 1438, the ship's head was 007° and turning slowly to port. Soon after this, the turn to port around Garden Island was started and at 1439 the ship's head was 345°, having swung through 22° during the last minute. The rate of turn to port at 1439 was increasing, consistent with a turn towards the next course of 306° (T).

At 1439½, the heading was 329° and the average rate of turn to port since 1439 was 32° per minute, but decreasing. Soon after, the turn to port slowed significantly and at 1440 stopped with the heading on 320° before a turn to starboard developed. The rate of turn to starboard increased with the heading passing 343° at 1441, after which the swing slowed under maximum port helm. At 1442, the heading was 353° and, as the ship grounded, its heading immediately swung to port.

Figure 8: Course recorder chart

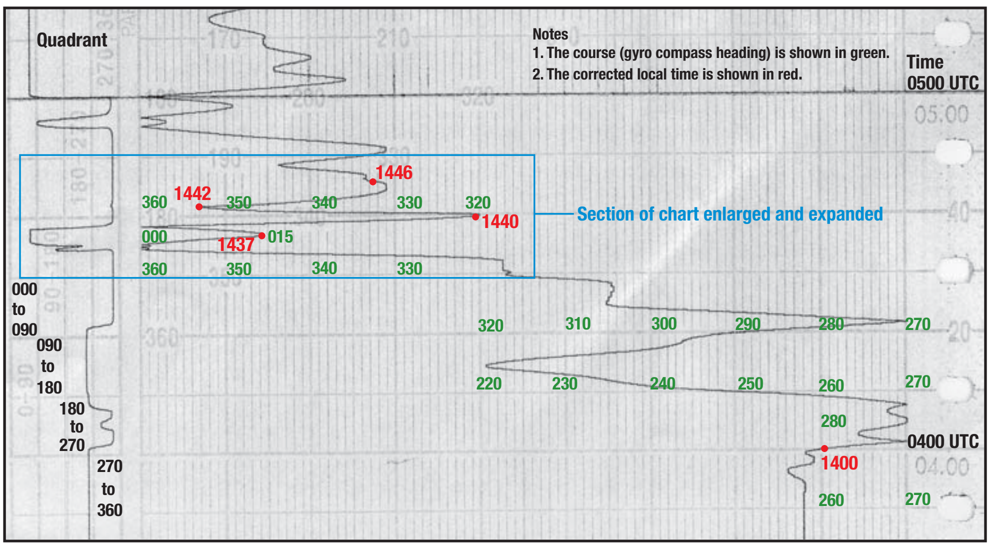
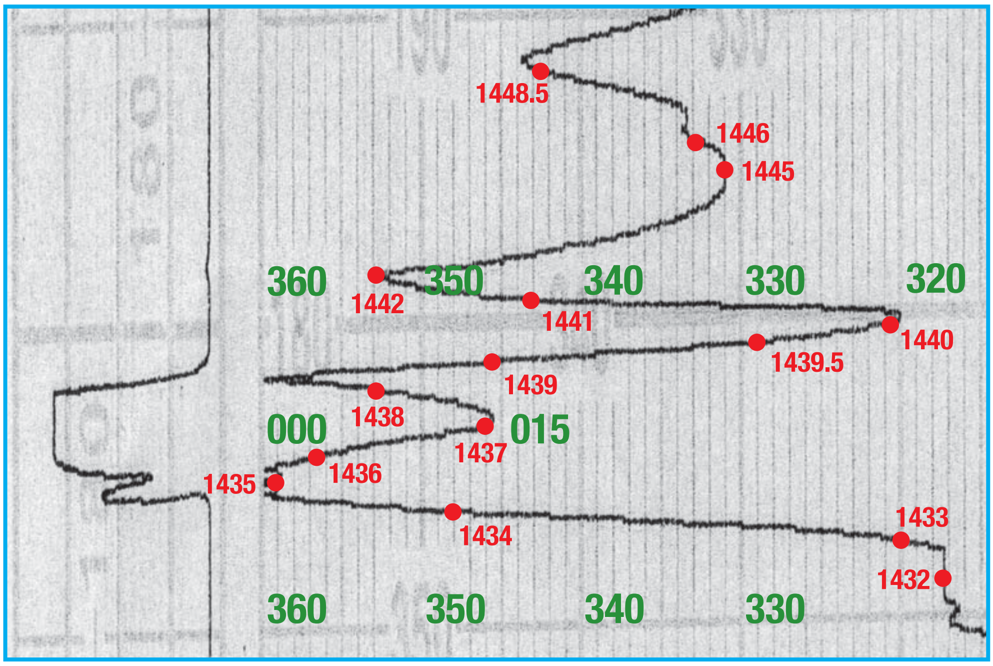


Figure 9: Section of course recorder chart enlarged and expanded



2.3 Conning position

From about 1423, the pilot conned the ship from the starboard additional conning position (Figure 10). He could not read the rudder angle indicator from that position. When he moved from there to check the rudder angle just after 1440 he observed that the rudder was nearly hard-over to starboard and not to port as he had intended. If the incorrect use of starboard rudder had been observed earlier the grounding may have been prevented.

Figure 10: The view from the starboard additional conning position

SOLAS, Chapter V, Regulation 12, Shipborne navigational equipment, paragraph (m) applicable to *Crimson Mars* states:

> … ships … shall be fitted with indicators showing the rudder angle, the rate of revolution of each propeller … All these indicators shall be readable from the conning position.

During the investigation ClassNK advised the ATSB that they interpret this to mean that all indicators required by the provisions of the SOLAS regulation should also be readable from the 'additional conning positions'. ClassNK also stated that these positions are normally located approximately 2.5 m from the conning position which is usually on the centreline and that the indicators near the centreline are not difficult to read from such positions. They required additional indicators when additional conning positions were distant from the centreline such as on bridge wings.

Indicators for rudder angle and main engine revolutions should have, on this interpretation, been readable from all the conning positions on the bridge of *Crimson Mars*. The indicators had flat faces and mounted on the bridge front facing directly aft and therefore were not readable from either additional conning position. They were, however, readable from positions B and D (Figure 2), about three metres on either side of the centreline. Each of these positions was directly in line with a plastic plaque fixed above the bridge front window in front of it, indicating the line of sight to the appropriate steering light[12].

In submission ClassNK stated:

> The aim of the additional conning position is "giving a clear view".
>
> SOLAS Ch. V/12(m) is required the indicators shall be readable from the conning position. The conning position means centre conning position and is not including the additional conning positions.
>
> This is to clarify that it is not necessary to provide an additional rudder angle indicator and a shaft revolution indicator at each additional conning position in accordance with NK rule, ISO standard and IMO MSC/Circ.982 under the SOLAS Convention.

The above, however, is only the interpretation by ClassNK of the SOLAS regulation. The regulation does not state that it refers to a conning position on the centreline or a primary conning position, nor implies secondary or additional conning positions to which its requirements do not apply. It is also reasonable to interpret that the requirements that apply to a conning position in the regulation apply to all conning positions on a ship's bridge.

The sign indicating the starboard additional conning position on the bridge of *Crimson Mars* may have initially prompted the pilot to take this position in the circumstances. When it became apparent that he could not read, in particular, the rudder angle indicator he should have moved to a position in which he could read it. The rudder angle indicator should be readable from a position taken while conning a ship.

12 Steering lights are fitted near the stem of a ship at a height close to the height of eye level from the bridge from where they must be clearly visible. They are blue when illuminated and provide a visual reference to the heading of the ship in darkness when navigating in canals, channels, rivers etc.

2.4 Bridge resource management (BRM)

Every pilotage passage is a high risk undertaking and the pilot's primary task is to manage the risk to the port by piloting the ship safely. The pilot should have adequate and appropriate support from the ship's bridge team. The River Tamar is a particularly difficult pilotage in parts with some critical turns. Effective BRM, using several recognised techniques including planning, should be used to complete it safely.

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.[13]

Crimson Mars's safety management system (SMS) procedures emphasised BRM as a way to reduce human errors and omissions through a simple system of checks and the delegation of duties. They stated that the pilot becomes part of the bridge management team and detailed the required interaction between the bridge team and the pilot.

The master's standing orders posted on the bridge included the duties of the watch officer when a pilot was on board. These included cooperation with the pilot, maintaining an accurate check on the ship's position and movements, and actions to take if in any doubt.

The ship's bridge procedures were consistent with the Bridge Procedures Guide[14]. Although the procedures did not directly refer to the guide, a copy was included in the publications library on the bridge. The guide is recognised internationally as providing practical guidance, procedures and checklists for seafarers, consistent with promoting best navigational practice, including BRM.

AMSA Marine Notice 34/2002 states:

> Investigation and analysis of a series of collisions and groundings have shown that proper Watch keeping and Bridge Resource Management (BRM) techniques could have prevented some incidents. The human and organisational errors underlying these casualties arose from insufficient pre-passage planning and briefing of the bridge team, lack of sound BRM processes and poor navigational practice. Some of these errors were:
>
> - failure to delegate tasks and assign responsibilities,
> - failure to set priorities,
> - insufficient support to master and/or pilot,
> - inadequate monitoring,
> - misuse of electronic navigation aids and;
> - failure to detect and/or challenge deviation from the passage plan and standard operating procedures.

To varying degrees, as discussed below, all of the errors noted in the AMSA Marine Notice were identifiable in the events on the bridge of *Crimson Mars* on 1 May.

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

14 Bridge Procedures Guide, Third edition 1998, International Chamber of Shipping.

2.4.1 Passage planning

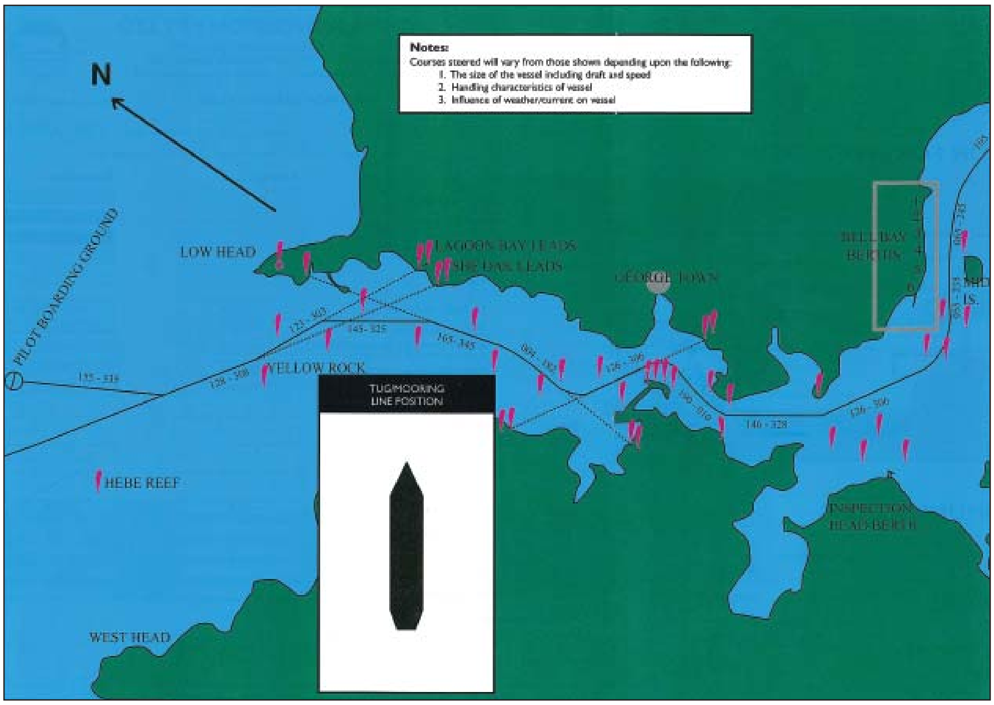
Passage planning is acknowledged as being necessary to allow the entire bridge team to arrive at a common mental model of what 'should' happen during the passage and thus ensure the ship can be navigated safely between ports from berth to berth. The margins of safety in restricted coastal waters, such as the pilotage from Bell Bay, can be critical, making the time available to take corrective action limited. Careful passage planning therefore can be used to make a pilotage passage safer.

The ship's passage plan, in a tabular form, met the requirements of a berth to berth passage plan. The second mate had prepared the passage plan for the voyage from Bell Bay. The master and mates had signed off on the plan, but no briefing or discussion took place.

TasPorts' procedure for ship departures stated that 'it shall be the responsibility of the pilot to plan each specific pilotage, and this process shall include the consideration of a number of variables'. The variables to be considered were defined in, but not limited to, a list provided in the procedure. The pilot was also required to exchange information with the ship's master and then assess the situation, including an assessment of the crew and ship capability. When satisfied, the pilot was to discuss the departure plan and any modifications to the plan with the master and complete the port's passage plan.

The port's standard passage plan included a diagram indicating the intended tracks (Figure 11). Course alteration positions were not specified with reference to latitude and longitude, or bearing and distance from a charted feature. Without significant local knowledge or more detailed information it is not possible to mark the tracks, exactly as they appear in the diagram, on a navigational chart.

Figure 11: Section of the diagram included in the port's standard passage plan



In submission the pilot stated:

> Because of the dynamic nature of the waterway caused by varying tidal and fresh water (rain) conditions, the courses and turn points can only be generic by design as both courses and turn points will vary with tidal conditions fresh water coming down river due to heavy rain and the particular handling characteristics of the vessels themselves, which often can only be established after commencing the pilotage.

While it is recognised that the wheel-over points for alterations as well as the compass courses steered will vary in every pilotage, the planned track, or true courses, in the pilotage should remain within defined safe limits. It is these courses, or legs of the planned track, for which it is possible and necessary to specify the course alteration positions to enable a ship's crew to mark the plan to be used on their chart. When a leg is short and lies along an arc with an appropriate turn radius, the crew planning a pilotage passage mark this on the chart and are aware that the turn radius is a variable as are the compass courses steered during a pilotage. Without sufficiently detailed information it is not possible for the crew to understand the intended plan and thus reduce the risk of a 'single person error' by the pilot.

From Bell Bay to the pilot boarding ground, the port's passage plan has 11 separate course legs with three course alterations of 58° or more. The passage north of Bryants Bay, or from about halfway on the outbound course of 328°, was described by the pilot as a critical area. The margins of error for a safe passage in this area, and as far as the river entrance off Yellow Rock beacon, are very small.

The outbound courses off Garden Island in the port's passage plan involved an alteration of course from 010° to 306°. The courses marked on the ship's chart for this turn were 026°, 000° and 306°. The manoeuvre for rounding Garden Island outbound, according to the pilot, started when the ship was off Saltpan Point and could be complicated as it was a dynamic area and involved considering many variables. The area off Garden Island should therefore be navigated with extreme caution.

The courses marked on the chart by *Crimson Mars*'s crew were based on, but different to, the port's standard passage plan. There was no indication on the chart, either by amendment to the marked courses, or otherwise, that reflected the pilot's intended track and neither were any differences discussed. Therefore, the ship's crew did not have a clear picture of the pilot's intentions and the bridge team did not develop a 'shared mental model' of the passage. Had this been developed it would have promoted a clearer understanding of the pilot's intentions, the support that he should be given, acceptable limits, and the priorities and responsibilities of the bridge team.

2.4.2 Briefing and communication

The master/pilot information exchange is central to developing a 'shared mental model'. The information exchange prior to the departure of *Crimson Mars* from Bell Bay on 1 May, however, was minimal. It consisted of checks of the listed items on the port's passage plan and the making fast of the tugs. The pilot assumed that since the master had no questions or concerns and had been to the port before, the master was comfortable and familiar with the passage.

The pilot stated that to build rapport he had, as he always did, a ‘one to one communication’ with the helmsman. The helmsman stated that his only recall of the conversation was that the pilot was to be informed if he thought any helm orders given were ‘stupid’. The function of the helmsman is not to second guess a pilot but to steer the courses as instructed. He is not a navigator and is not required to understand or remember the courses required. The helmsman was not briefed beforehand on the courses to steer, or otherwise made aware of what courses should be steered. The master, not the helmsman, was in the best position to determine if the pilot’s orders were appropriate and correct and a similar ‘one to one communication’ with the master and the third mate on the subject may have been more effective.

The third mate perceived the pilot’s communication with the helmsman as an inappropriate ‘joke’ that could affect the helmsman’s performance. The master too thought that it must have been a ‘joke’. In spite of this perception, neither the master nor the third mate made any attempt to either put the helmsman at ease or clarify with the pilot by asking him what was expected of the ship’s bridge team.

While the purpose of the ‘one to one communication’ may have been to encourage ‘challenge’ by the Filipino helmsman, the lack of cultural awareness by the pilot made it ineffective. Such awareness provides a better understanding of the support that can be expected and the challenges that may be faced when working with the crew of a particular nationality. The rank and nationality of *Crimson Mars*’s helmsman made it unlikely that he would ever challenge a pilot’s order.

Communication between the pilot and the third mate may also have assisted in preventing the grounding. The pilot stated that the master, not the pilot, was in charge of the ship and must allocate responsibilities to his officers. While the master retains command and responsibility for the ship and its crew, and should apply and encourage BRM, this does not, and is not meant to, prevent the pilot using BRM tools. Involving the third mate, for example, by delegating a task such as monitoring the rudder angle which was not readable from the pilot’s position, or defining priorities such as monitoring helm orders, could have reduced the risk of an error going unnoticed.

Other than the brief pre-departure information exchange there was little or no communication between the pilot, the master and the third mate until the grounding was imminent. The inadequate communication led to responsibilities being undefined, and did not encourage an atmosphere for ‘challenge and response’.

In submission the pilot stated:

> It is the master and mates professional responsibility to challenge, i.e. they should not need to be invited to do so, and the pilot cannot be expected to change the procedural culture of the ship he is on for the relatively short duration, whilst piloting.

It is not expected that the pilot can change the 'procedural culture' of a ship, but it is essential that the pilot should adapt his communication and actions appropriately to the situation. By using recognised BRM tools and techniques to supplement other piloting skills, the pilot can encourage adequate support from the crew. It is the responsibility of the master as well as the pilot to encourage teamwork and 'challenge'.

In this case the pilot's communication with the other member's of the bridge team was neither open nor interactive, and did not encourage teamwork. The helm orders were, for the most part, the only communication that took place.

Helm orders

The master and third mate stated that the pilot did not always acknowledge the helmsman's response or 'close the loop' with his helm orders. The pilot stated that he routinely listened for a response from the helmsman to his helm orders. If he did not get a response he would repeat the order, but if he got an appropriate response he would not necessarily acknowledge it.

The helmsman stated that he responded to all the pilot's helm orders by repeating the order and confirming the rudder angle after executing the order.

The pilot did not consistently use the 'midships' order during the pilotage including when giving his last helm order to prevent the grounding. He also did not recall if the order prior to the first incorrect use of starboard helm before the grounding was 'midships'. The 'midships' order ensures that there is no ambiguity or confusion when the rudder is ordered from port to starboard or vice-versa. It effectively reduces the risk of the rudder being applied the wrong way by first putting it in a neutral position.

The pilot did not normally use hand signals to enhance the communication of helm orders to a helmsman. The use of hand signals also serves as a self check for the pilot. The thought process of a helm order tends to ensure that the appropriate hand signal is given. A contradictory verbal helm order therefore will be immediately noticed.

The use of the 'midships' order and/or hand signals can effectively reduce the risk of an error and improve the probability of detecting it. Their use may have prevented the grounding.

2.4.3 'State of the bridge'

The turn off Garden Island was a critical part of the passage in a dynamic area. Executing the turn requires local knowledge, skill, and effective monitoring. In such critical navigation situations it is necessary to maintain an optimal 'state of the bridge' and good situational awareness.

The pilot's observations during the turn indicated that port helm was required but he made no attempt to check the rudder angle until after 1440. The pilot had moved to the starboard additional conning position at about 1423, so that he had a view forward, and of the radar display. The master, when he noticed the unexpected turn to starboard, was close to the port additional conning position. The rudder angle indicator was not readable from either conning position. Effective monitoring required the master and the pilot to position themselves so that they could read the rudder angle indicator.

The third mate stated that he was plotting a position on the chart just before the ship started to turn to starboard. However, there was no position plotted on the chart after 1436 until after the grounding to indicate that he did do so. In the circumstances, for the crew to be just plotting positions on the chart was not an effective way of monitoring the turn off Garden Island.

During the turn, from about 1439½ until just after 1440, no one monitored three consecutive helm orders and their execution. None of the bridge team made any observations in sufficient time to take, or initiate, any corrective action. The situational awareness during the turn was manifestly inadequate and the ‘state of the bridge’ can only be described as inattentive at this critical phase of the pilotage passage.

2.4.4 Management of workload

No effective briefing or discussion about the pilotage passage took place at any stage, and therefore there was no prioritising, delegating or defining of duties and tasks.

Crimson Mars’s SMS detailed BRM procedures, consistent with recognised principles and objectives. The procedures required clearly defined bridge team duties including goals, objectives and guidelines, including communication between bridge team members and the pilot.

The procedures also defined a watch condition for the bridge of *Crimson Mars* by structuring the bridge team based on the environment in which the ship was operating. The factors to be considered were stated as including the mechanical condition of the vessel, weather, traffic, location and sea state. An example of the watch condition levels, in tabular form, with defined responsibilities for bridge team members was included in the ship’s procedures (Figure 12).

Figure 12: *Crimson Mars*’s bridge watch condition levels

BRIDGE TEAM DUTIES BY WATCH CONDITION							
Watch Condition	BRIDGE TEAM DUTIES						
	COMN	COLLISION AVOIDANCE	Radio Communi-cations	Naviga-tion	Other Duties	Helm	Lookout
LEVEL 1	Watch Officer					AB	
LEVEL 2	Master	Watch Officer				AB	AB/OS
LEVEL 3	Master	Watch Officer		Watch Officer		AB	AB/OS
In case of special operation, watch condition Level 2 or 3 shall be used.							

The table included a note that level 2 or 3 should be used for 'special operations'. While 'special operations' were not defined in the procedure, the content of the watch condition table implied that levels 2 and 3, as they required greater resources, involved escalating levels of risk. A copy of the table, with the 'special operations' note omitted, was posted prominently inside the bridge.

The ship's passage plan identified the use of level 3 for the pilotage passage from Bell Bay. Level 3 required that the master, two watch officers, an able seaman and an additional able or ordinary seaman be present on the bridge. In addition to navigation, helm and lookout, the duties defined for the five person ship's bridge team included communication and other duties such as attending the main engine telegraph and recording activities or events in the log book.

The bridge team on 1 May was one officer and one seaman short of the planned requirement. Had the planned number of ship's crew been included in the bridge team, the workload may have been better managed with more effective monitoring.

Monitoring the helm orders

Monitoring the helm orders and their execution during the pilotage should have been amongst the higher priorities for the bridge team. There is little time available to correct errors, particularly during the turn around Garden Island.

The Bridge Procedures Guide, Section 3.3 states:

> Verbal orders from the pilot also need to be checked to confirm that they have been correctly carried out. This will include monitoring both the rudder angle and rpm indicators when helm and engine orders are given.

The guide also includes a comprehensive checklist for pilotage. The defining of responsibilities within the bridge team and monitoring the execution of orders are specific checks in the checklist. This highlights the critical aspect of monitoring the pilot's helm orders and their subsequent execution by the helmsman.

Both the master and the third mate thought that the other was monitoring the helm orders. Neither of them could recall any of the pilot's helm orders or the helmsman's verbal responses leading to the grounding. Both recalled hearing the voices of the pilot and the helmsman, but not the words spoken by either of them. This suggests that the monitoring of helm orders consisted mainly of waiting to hear a verbal response from the helmsman after the pilot's order, indicating little, if any, concern about the orders or their execution being appropriate and correct.

The third mate was certain that he did not hear the pilot acknowledge the helmsman's verbal response before the turn to starboard, but assumed the response was satisfactory to the pilot as he did not always 'close the loop'. While he and the master noted during the pilotage that the pilot did not consistently 'close the loop' they did nothing to address this. Repeating the helm order or rudder angle when the pilot did not acknowledge a response, observing the rudder angle indicator closely and increased vigilance would have significantly improved the ineffective monitoring of helm orders and probably prevented the grounding.

Monitoring the progress

The small margins of error in the pilotage passage made it necessary that the safe progress of the ship along the planned tracks be closely monitored at all times.

The Bridge Procedures Guide, Section 2.5 states:

> Of particular importance is the need to monitor the position of the ship approaching the wheel over position at the end of the track, and checking that the ship is safely on the new track after alteration of course.

The guide also details monitoring techniques with transits ahead and abeam and bearing lines, including clearing bearings used for visual monitoring. Parallel indexing, clearing bearings and ranges are recommended for radar monitoring.

The pilot, in the clear conditions, used visual monitoring techniques and his local knowledge to conduct the pilotage. He did not consider it necessary, in the circumstances, that he receive any support from the master or the third mate. He did not involve them by delegating tasks, asking for information or requesting any assistance.

There was no discussion between the pilot and the master about visual or other monitoring of the passage, so the master was not any better informed or aware of the execution of the pilotage than before their information exchange. The master did not use any appropriate radar or visual monitoring techniques but instead relied mainly on positions plotted on the chart by the third mate.

The third mate considered his main task was to attend the main engine telegraph, and he continued to closely attend it even after navigation full ahead was ordered. His other priority was to plot positions on the chart.

The chart plotter was used and this equipment projected the ship's global positioning system (GPS) position with a red light onto the underside of the navigational chart. The plotter allowed the ship's position to be monitored in real time. It was however, according to the master, used for reference only. The third mate plotted a GPS position on the chart and then measured the bearing and distance of a charted feature from this position. He then compared these with the electronic bearing line (EBL) and the variable range marker (VRM) measurements of that feature on the radar. He did not record any positions in the log book or the bell book. This method of monitoring the passage was, in the circumstances, ineffective and an inappropriate use of resources.

Both of the radars had input from the GPS unit, with map and other functions for monitoring. The map function included route planning for real time monitoring but it was not used. Both GPS units provide visual and audible warnings for a number of user-defined conditions but these were not set up. The ship's plan required that parallel indexing be used to supplement the position fixing but only some general use was made of the radar, mainly by using its EBL and VRM. Use of the available equipment appropriately could have significantly enhanced the monitoring of the ship's position during the passage.

The available aids to navigation, including the chart plotter, were not used to enhance monitoring the ship's progress and to manage the workload. The ship's log and bell book had no entries from 1420 until 1442. The monitoring of the passage was inadequate and the lack of proper workload management increased the probability of errors going undetected.

2.4.5 'Single person errors'

Effective BRM uses all available resources to mitigate the risk of a 'single person error'. None of *Crimson Mars*'s bridge team did anything effective to detect, or recover from, the errors which led to the grounding. They did not adequately monitor the actions of other members of the team.

The pilot relied completely on the helmsman to correctly execute all of his helm orders. The master and third mate relied completely on all of the pilot's orders being correct, as well as the helmsman correctly executing them. The execution of the passage was left to the pilot and the helmsman without any effective monitoring.

There were opportunities to use the 'challenge and response' tool by challenging the pilot when he used his mobile telephone or when the ship's position was significantly off the track marked on the chart. However, the master and the pilot did not effectively create an environment that fostered 'challenge and response' and consequently this tool was not used. This led to inadequate monitoring of the pilotage passage, and resulted in 'single person errors' occurring and not being detected in time to prevent the grounding.

2.5 Use of mobile telephones

Crimson Mars's managers had provided the master with a copy of the Britannia News Summary[15], issue number 288, 2 December 2005. It included guidance on the use of mobile telephones based on MGN 299[16]. MGN 299 entitled 'Interference with safe navigation through inappropriate use of mobile phones' covers the subject comprehensively. Some of its key points are:

> Interference, in this context, relates to the distraction caused by making or receiving mobile phone calls at inappropriate times during the conduct of the vessel's navigation and conning.
>
> Such activity is liable to demand the attention of bridge personnel when full attention should be devoted to the safe and efficient navigation of the vessel.
>
> Consideration should also be given to prohibiting all mobile phone usage when navigational requirements demand the individual attention of all those responsible for the safe conduct of the vessel.

The pilot stated that it was customary for pilots to use a mobile telephone, supplied by TasPorts, to improve communications, particularly when there was a need to be discreet and for emergency communication with tugs. He cited his call to port control after the grounding as an example of such a need. TasPorts' procedures contained no instructions or guidance on the use of mobile telephones during pilotage for emergency or routine operations.

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15 A publication of the Britannia Steam Ship Insurance Association Limited, United Kingdom.

16 Marine Guidance Note 299, Marine and Coastguard Agency, United Kingdom.

The pilot received a personal telephone call on his mobile telephone at about 1436, as the ship was approaching Saltpan Point and telephone records show that the call was of 23 seconds duration. The pilot stated that he told the caller he was busy, and because he was focused on conning the ship, he did not press the cancel button on his telephone thus extending the duration of the call. He also stated that he was unaffected by the call as it was three minutes before the turn off Garden Island and also that he did not think the crew, at any stage, were affected by it. After the grounding, from 1445 onwards, he spoke with port control a few times using his mobile telephone.

The pilot did not discuss the use of his mobile telephone with any of the bridge team. The master stated that its use was inappropriate and that he was not sure if the pilot was concentrating on the pilotage. The third mate believed that the master, rather than he, should 'challenge' the pilot in such a case. In any event there was no 'challenge', increased vigilance, or any other action by the bridge team in response to the use of the mobile telephone by the pilot.

MGN 299 concludes that:

> There is a compelling need for clarity of purpose when conducting the safe navigation of a vessel which endorses the requirement for an active management policy for the use of mobile phones on the bridges of ships at all times, but especially when navigation risks are higher.

In submission the pilot stated:

> I do not believe that the pilot's mobile phone use before Salt Pan Point contributed to the grounding at Long Tom Reef, nor do I believe that discrete communications by mobile phone after the grounding negatively affected the return of the vessel to anchor at Bell Bay.

While the pilot did not use his mobile telephone when he was giving the helm orders leading to the grounding, he did so a few minutes before. Using a mobile telephone causes a distraction and interferes with the attention of the user and the entire bridge team. This distraction interrupts the thought processes and concentration of the bridge team and is not restricted to just the periods that a mobile telephone is used. In any event, there is overwhelming evidence in the transport industry that the use of a mobile telephone by a person concurrently with operating a transport vehicle is a distraction to the prime task of operating the vehicle.

The ATSB investigation report number 162, the grounding of the container ship *Bunga Teratai Satu* on 2 November 2000, concluded that the distraction caused by the use of a mobile telephone was the significant unsafe act that resulted in the grounding. The incident highlighted the distraction that mobile telephones can cause to the user, as well as to others.

The use of mobile telephones is contrary to good BRM principles, hinders situational awareness and prevents an optimal 'state of the bridge'.

2.6 Contingency planning

Planning for emergencies adds significant control in managing them. Contingency planning is a risk management tool. Anticipation and preparation for an adverse event makes the reaction to it more effective. The reaction may then be one from a known and prepared range of options rather than an unknown instantaneous reaction in an unexpected and stressful situation. Learning only from real emergencies is not practical or possible and therefore should be enhanced through training, ideally, simulation in a controlled environment.

Since 1993, including this incident, seven groundings involving large ships in the River Tamar or its approaches have been reported to the ATSB. The risk of grounding in the river is therefore reasonably foreseeable and measures need to be put in place to reduce the risk, and the potential adverse consequences, of grounding.

Grounding was identified by TasPorts in their emergency management plan. The plan deals with notifications and other procedures in the aftermath of an emergency. Strategies and measures to prevent emergencies, including grounding, are not part of the plan. However, TasPorts' procedures for ship departures addressed the prevention of emergencies and stated:

> Contingency planning shall include changes in ship's machinery, ship's performance, weather, navaids or tugs… should ensure the continued safe navigation of the ship…as well as the safety of the port's infrastructure. It shall be the responsibility of the pilot to have considered contingencies that may have to be put in place should unexpected events occur. In the event of an accident the Authority's appropriate response plan shall be activated…

TasPorts placed the first responsibility for contingency planning on the pilot and relied mainly on his ability and experience to respond to an emergency. Contingency planning, an integral part of passage planning, starts when the passage is first planned. It relies on preparation and using all available resources, including the combined knowledge of the port's pilots, to complement individual expertise in an emergency.

It is important that contingency planning for Bell Bay takes into account a safe and appropriate speed for the pilotage. An increased speed can improve steering, increase control by reducing set and leeway, and decrease the time in a critical area. However, it reduces the time available to take corrective action to prevent grounding and increases the impact and damage from it. There are other advantages and disadvantages of a higher speed that may be relevant and need to be considered with the variables of each pilotage. However, in every case the need for effective planning, execution and monitoring is necessary.

Grounding was also identified in *Crimson Mars*'s emergency response procedures. The ship's drill and training record indicated that the crew had been exercised in a drill for grounding on 20 March 2006. The contingency planning of the ship, however, was inadequate as shown by the response to the grounding on 1 May.

2.6.1 Emergency response and management

In responding to the emergency, events took place that involved high risks to the ship's crew, the environment, the ship and the port. The events may have included oil pollution, closure of the port, death and serious injury, and further damage to the ship. It was good fortune, rather than planning and risk assessment that limited the potential negative impact of the grounding and far more severe consequences, and that the angle of impact when the ship grounded did not cause damage to oil tanks further aft and result in pollution. It was also fortunate that the starboard anchor was not let go and that the ship, inadvertently, remained anchored after refloating and that no injuries resulted from the hazardous operation of cutting the anchor cable.

In submission the pilot stated:

> The inference that the Ports Emergency Contingency Procedures are inadequate does not hold up when seen in full hindsight, i.e. a fully laden 200 metre vessel coming back from a very precarious position in a narrow tidal river, to anchor at Bell Bay without further damage is not just good luck!

The planning for the voyage and the response to, and the management of, the grounding by the pilot reveal the inadequacy of TasPorts' procedures for contingency planning. The potential negative impact of the grounding may have been much more severe. The lessons learned from this incident should assist TasPorts in reviewing their procedures for contingency planning and emergency response to grounding.

After the grounding, the pilot used his ability and experience to manage the situation. With hindsight or with the benefit of adequate contingency plans he may have appropriately considered if, and how, the port anchor should be retrieved and later not suggested cutting the anchor cable. Appropriate planning and preparation could have complemented his effort, ability and experience.

The emergency response by the crew of *Crimson Mars* also reveals the inadequacy of the ship's procedures. Good seamanship, safe working practices and being fully conversant and familiar with the ship's equipment and procedures is essential to mitigate the potential negative impact of an emergency. In this incident the operations undertaken on the forecastle with the port anchor windlass and cable resulted in unnecessarily high risks to the crew.

Initial response

The decision to run the main engine at emergency full astern and let go both anchors was consistent with an attempt to reduce the impact and damage from the grounding.

The main engine was on engine room control during the pilotage. This was the usual practice on the ship, even though the automated system for bridge control of the main engine was operational. While the response to the emergency full astern order was prompt it did involve a delay. Bridge control of the main engine is provided to allow an automated response to bridge telegraph orders. This response will normally be much quicker than the crew operating the main engine manually from the engine control room and also prevents a wrong way response.

The ship grounded on a heading that was nearly at right angles to Long Tom Reef. The edge of the reef rises steeply rather than a gentle slope from the adjacent deep water. This prevented the ship from moving too far onto the reef, and the impact was absorbed mainly by its bulbous bow. Significantly, several fuel oil tanks located aft of the number one ballast tanks along the bottom of the ship's hull remained intact. Had the ship grounded at a different angle, the hull could have been damaged further aft by a glancing blow which would have probably resulted in oil pollution from ruptured fuel oil tanks.

The heading at which the ship grounded and the fact that the starboard anchor was not let go was fortunate, because it resulted in the prevention of oil pollution and allowed the ship to retain one operational windlass and anchor.

The attempt to retrieve the anchor

When the pilot observed the ship moving astern after the grounding he asked for the port anchor to be retrieved. He stated that he hoped to manoeuvre the ship to one of two emergency anchorage positions known to him. One of these positions was south of Garrow Rock and the other was south of Long Tom beacon. Neither position was marked on the chart, discussed in the master/pilot information exchange, indicated on the port's passage plan or documented in the port's procedures.

Had the anchor been successfully retrieved it would have been difficult to maintain control of the near stationary ship in the confined area of that part of the river, or manoeuvre it to any safe position. The optimum use of the ship's main engine and rudder would have been necessary to prevent a further grounding, since the tugs were still a considerable time away. It is probable that it would have soon become necessary to let go an anchor to maintain control of the ship.

In submission the pilot stated:

> Had the vessel been left in the position it grounded it most probably would have pivoted on the grounded bow section with the remaining flood tide, swinging the vessel broadside to, onto Windmill Point.

While the thought that the ship may pivot on its grounded bow probably influenced the pilot's decision to retrieve the anchor when he saw the ship moving astern, it is clear that he was reacting to uncontrolled events appropriately, according to him, rather than effectively applying or adapting a carefully planned emergency response to the situation at hand. Without the benefit of such a planned response he had little time to adequately consider his decision to retrieve the anchor, or the method of doing so.

The anchor was dragged a significant distance with the ship's sternway of 1.8 knots at 1444½ probably increasing as the main engine continued to operate at emergency full astern for the next four minutes while the crew attempted to retrieve the anchor. The ship's sternway would have been readily apparent due to its proximity to Windmill Point together with the speed indications on bridge equipment.

In attempting to retrieve the anchor the pilot and the ship's crew did not consider the heavy load on the taut cable as the anchor was being dragged. Engaging the windlass in these circumstances placed a very heavy load on the windlass and resulted in the failure of its hydraulic motor. While the motor should have been protected by the relief valve in the hydraulic system, either the relief valve did not operate as designed, or it did not relieve the pressure quickly enough to prevent the motor's failure.

The pilot stated that after the windlass was damaged he had no option but to try and drag the anchor to a position of relative safety east of Garden Island. After 1451, he did use the main engine astern to position the ship.

In their different roles, the pilot, the master and the chief mate did not appropriately assess the situation in deciding, and then attempting, to retrieve the anchor. Their assessment should have included:

- The possibility that the ship, which had just refloated, might inadvertently be pulled back towards the anchor and onto the reef with the windlass heaving in the anchor cable.
- The risk involved in attempting to retrieve such a heavily loaded anchor cable.
- The possibility of dragging the anchor using the ship's main engine, and the safest way of doing so.

The attempt to heave on the heavily loaded anchor cable made damage to the windlass very likely and predictable. Therefore, the damage could have been prevented.

Cutting the anchor cable

The pilot stated that if it became dangerous to remain in the position east of Garden Island when the tide ebbed, he intended to quickly release the anchor cable so as to be able to manoeuvre the ship to the position south of Long Tom beacon. He suggested to the master that this should be done by gas cutting the cable. The pilot believed that slipping the bitter end would involve the ship's crew entering the chain locker, and therefore could be dangerous and complicated. Neither the master, nor the chief mate or the chief engineer considered, or suggested, slipping the bitter end.

Like most modern ships, *Crimson Mars*'s anchor cable bitter end slipping arrangement is provided outside the chain locker and is accessed from the forecastle store. The bitter end can be safely slipped by knocking out a pin with a hammer. The hammer provided for the purpose was located in a box close by. The ship's crew was not aware of the location of the hammer, or its purpose. The pilot stated that he was not informed about the safe and easy access to the bitter end outside the chain locker.

The use of a wire stopper and preparing an anchor buoy suggests that some thought was given to the operation. However, the master, chief mate and chief engineer were collectively unable to effectively assess the risks during the time that was available to them before the tugs were made fast. It is possible that the intention was to connect the anchor buoy while the wire stopper took the weight of the cable. If this was the case, the timing of the wire parting resulted in the crew not being exposed to the additional risk of working on an inappropriately stoppered anchor cable.

Cutting the anchor cable was an unnecessarily hazardous operation with high risks to the crew.

3 FINDINGS

From the evidence available, the following findings are made with respect to the grounding of *Crimson Mars* at 1442 on 1 May 2006 on Long Tom Reef in the River Tamar. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

3.1 Contributing safety factors

1. The use of starboard instead of port helm at about 1440, during the ship's turn off Garden Island, led directly to the grounding.
2. The pilot selected, and remained at, a conning position from which the rudder angle indicator could not be read. He made no attempt to visually, or otherwise, check the rudder angle until the grounding was unavoidable.
3. Bridge resource management was ineffective because:
   - The pilot's and the ship's passage plans were different but the pilot's intended passage plan was not discussed. This resulted in the crew not having a clear picture of the pilot's intentions, the support he should be given and their priorities.
   - The communication on the bridge during the pilotage was minimal, did not encourage 'challenge and response' and also resulted in the bridge team not developing a 'shared mental model'.
   - The planned number of ship's crew were not part of the bridge team, the bridge team did not use the available equipment optimally, or prioritise, delegate or define duties and tasks. This resulted in inadequate monitoring and an inattentive 'state of the bridge' at a critical phase of the passage.
   - The pilot did not consistently 'close the loop', use the 'midships' order or enhance his helm orders with hand signals and this increased the risk of a 'single person error'.
   - The helm orders and their execution were not monitored by the bridge team, and this resulted in the 'single person error' not being detected in time to prevent the grounding.
4. The pilot's use of a mobile telephone in the time before the grounding was inconsistent with good navigational practice and may have been a distraction.
5. The rudder angle indicator and the main engine tachometer were not readable from the 'additional conning positions'. These positions therefore did not comply with the relevant SOLAS regulation.

3.2 Other safety factors

1. The contingency planning, and risk assessment by the master and pilot after the grounding, was inadequate. This resulted in the unnecessarily hazardous operations to retrieve the anchor and to cut the anchor cable.
2. The indicative diagram provided in the port's passage plan did not provide the ship with sufficient information to assist in the preparation of the ship's passage plan.

4 SAFETY ACTIONS

4.1 ATSB recommendations

MR20070001

Pilots and masters should ensure that they are able to read, or otherwise be able to check, the rudder angle when conning a ship. They should also ensure that the conventions governing helm orders are observed, particularly the use of 'midships' when changing rudder direction, and 'closing the loop' when communicating orders to a helmsman. The use of hand signals to enhance the communication of helm orders should also be considered.

MR20070002

TasPorts should consider reviewing their procedures with respect to contingency planning with a view to providing pilots with adequate support aimed at preventing groundings and ensuring that a pilot's response to grounding is effective and helps to mitigate the potential adverse consequences.

MR20070003

TasPorts should review their procedures to ensure that the use of mobile telephones by pilots, if at all permitted, does not interfere with the safe navigation of ships in pilotage areas.

MR20070004

TasPorts should consider revising the standard passage plan for Bell Bay, and its means of dissemination, to make it possible for ship's masters and mates to use it when preparing ship's passage plans.

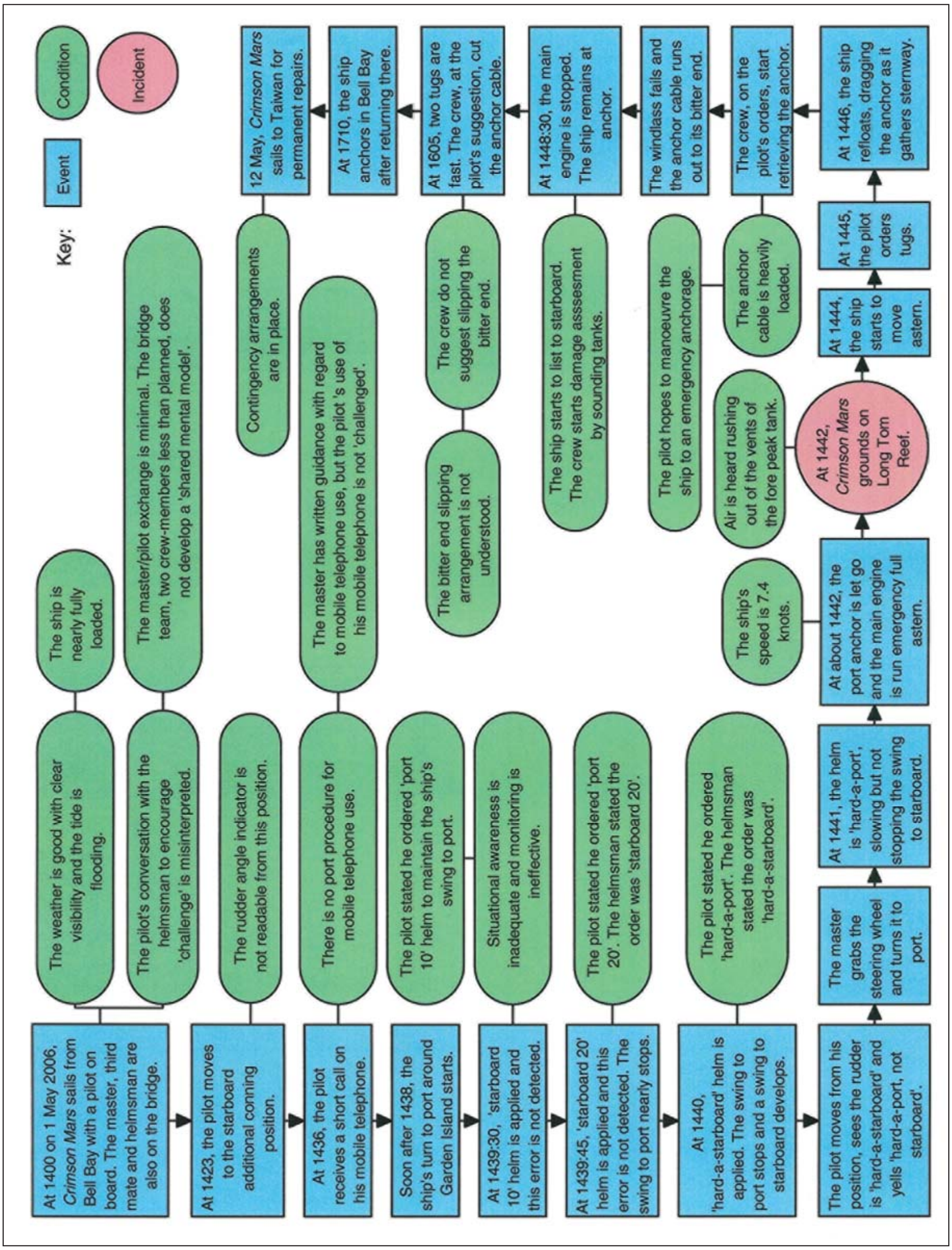
MR20070005

ClassNK should review the conning positions identified on *Crimson Mars*, and other similar ships, with a view to ensuring that rudder angle indicators are readable from all conning positions.

MR20070006

The managers of *Crimson Mars* should review their safety management system with a view to ensuring that any response by ship's crews to an emergency is effective and safe.

5 APPENDIX A: EVENTS AND CONDITIONS



6 APPENDIX B: SHIP INFORMATION

6.1 *Crimson Mars*

IMO Number	9244697
Call sign	9VAL2
Flag	Singapore
Port of Registry	Singapore
Classification society	Nippon Kaiji Kyokai (ClassNK)
Ship Type	Woodchip Carrier
Builder	Shin Kurushima Dockyard Company, Japan
Year built	2002
Owners	Lily Virgo, Singapore
Ship managers	Sandigan Ship Services, Philippines
Gross tonnage	40 360
Net tonnage	21 658
Deadweight (summer)	49 917 tonnes
Summer draught	11.527 m
Length overall	199.99 m
Length between perpendiculars	193.50 m
Moulded breadth	32.20 m
Moulded depth	22.75 m
Engine	Mitsubishi Type 6UEC52LS
Total power	7545 kW
Crew	22

7 APPENDIX C: SOURCES AND SUBMISSIONS

7.1 Sources of information

The master, officers and crew of *Crimson Mars*

Tasmanian Port Corporation (TasPorts)

Nippon Kaiji Kyokai (ClassNK)

The Australian Maritime Safety Authority (AMSA)

Diving and Marine Services

Telstra Corporation

7.2 References

Admiralty Sailing Directions, Australia Pilot, Volume II, Seventh Edition 1999, The United Kingdom Hydrographic Office.

Australian Maritime Safety Authority, Marine Notice No. 34/2002.

Bridge Procedures Guide, Third Edition 1998, International Chamber of Shipping.

Brittania News Summary, Issue No. 288, 2 December 2005, Brittania Steam Ship Insurance Association, United Kingdom.

Maritime and Coastguard Agency, United Kingdom, Marine Guidance Note MGN 299 (M+F).

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

Rules for the survey and construction of steel ships, Part W, Navigation Bridge Visibility, ClassNK.

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

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 the master, chief engineer, chief mate, third mate, helmsman and the managers of *Crimson Mars*, ClassNK, the pilot, TasPorts and the Australian Maritime Safety Authority.

Submissions were received from ClassNK, TasPorts and the pilot, and were included and/or the text of the report was amended where appropriate.

8 APPENDIX D: MEDIA RELEASE

Ship grounds after rudder is put the wrong way

The ATSB has found that the use of starboard instead of port helm led to the grounding of the Singapore registered woodchip carrier *Crimson Mars* in the River Tamar on 1 May 2006.

The Australian Transport Safety Bureau investigation found that an unsuitable conning position, ineffective bridge resource management and the distraction caused by the use of a mobile telephone may have contributed to the helm being applied the wrong way. It was also found that inadequate monitoring of the helm orders and their execution led to the error not being detected in time to prevent the grounding.

At 1400 Australian Eastern Standard Time on 1 May, *Crimson Mars*, nearly fully loaded with a cargo of woodchips sailed from Bell Bay with a pilot on board. The sky was cloudy, visibility was clear with a light south-easterly wind and the tide was flooding. The ship's master and third mate were on the bridge for the pilotage and a helmsman was steering the ship as instructed by the pilot.

The pilotage progressed as intended by the pilot until about 1440 when a turn to port around Garden Island, a critical part of the passage, was being executed. During the turn, starboard instead of port helm was applied for approximately one minute. By the time the error was detected and maximum port helm applied at about 1441, grounding was inevitable. Soon after, the pilot ordered both anchors to be let go and the main engine to be run at emergency full astern in an attempt to reduce the effects of the impact. At 1442, *Crimson Mars* grounded on Long Tom Reef and shuddered to a stop as the port anchor was let go and the main engine was run astern.

At 1446, the ship, with its main engine running astern, moved off the reef and refloated. The pilot ordered the anchor to be retrieved. This resulted in the failure of the port windlass and the anchor cable running out to its bitter end, which held. The ship remained at anchor off Garden Island until two tugs that had been called to assist were made fast at 1605. The anchor cable was then cut, just above the hawse pipe, by the ship's crew using gas cutting equipment and left in the river together with the port anchor. The ship returned to the Bell Bay anchorage so that an assessment of the damage could be made. No oil spill or other pollution resulted from the incident.

The ship was severely damaged with its bulbous bow holed and pushed in, and ballast water tanks forward were breached. The damage could not be repaired in Bell Bay and over the next few days contingency arrangements were agreed upon by the ship's Flag State, classification society and the Australian Maritime Safety Authority.

On 12 May, with contingency arrangements in place, *Crimson Mars* sailed for Taiwan to unload its cargo and undergo permanent repairs in dry dock.

The ATSB investigation also found that the attempt to retrieve the port anchor and later the cutting of the anchor cable were unnecessarily hazardous operations. The ship's and the port's procedures for contingency planning and emergency response were considered inadequate.

The ATSB has made several safety recommendations with the aim of preventing similar incidents in the future.

Independent investigation into the grounding of the Singapore registered woodchip carrier *Crimson Mars* in the River Tamar, Tasmania, 1 May 2006