Australian Government
Australian Transport Safety Bureau


ATSB TRANSPORT SAFETY INVESTIGATION REPORT
Marine Occurrence Investigation No. 232
Final

Independent investigation into the breakaway and grounding of the Hong Kong registered bulk carrier

# Creciente

at Port Hedland, Western Australia
12 September 2006

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## 12 September 2006

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Figure 3 courtesy of DigitalGlobe Pty Ltd.

Figure 10 courtesy of Eurasia Shipping.





**Abstract**

At 1730 on 10 September 2006, the Hong Kong registered bulk carrier *Creciente* berthed in Port Hedland, Western Australia, to load a cargo of iron ore.

At about 0245 on 12 September, the almost fully laden ship broke away from the wharf under the influence of a strong ebb tide.

Despite the use of several tugs and the ship's engine, it was not possible to manoeuvre the ship back alongside the wharf. The harbour master decided to hold the ship in the deepest part of the port's entrance channel until the next high tide.

By about 0615 on 12 September, the ship was firmly aground in the channel and, at about 0950, it was successfully refloated.

The ATSB investigation found that the effective holding capacity of the ship's mooring winch brakes was reduced by the number of layers of mooring line on the winch drums and the poor condition of their brakes. The investigation also found that it was highly likely that the brakes had not been sufficiently tightened and that the mooring winches were not effectively monitored in the time leading up to the incident.

The investigation also found that neither the port authority nor the ship's master had identified the possibility of the ship breaking away from its berth and appropriately assessed the risks associated with this potential hazard.

The report issues two recommendations and five safety advisory notices to address the identified safety issues.

# THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. 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.

# ATSB INVESTIGATION REPORT TERMINOLOGY

**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: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious; or (c) another contributing safety factor would probably not have occurred or existed.

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

**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

On 8 September 2006, the Hong Kong registered, cape-sized[1] bulk carrier *Creciente* arrived off Port Hedland, Western Australia, after a voyage from Kokura, Japan, and anchored while waiting to berth to load a cargo of iron ore.

At 1730[2] on 10 September 2006, *Creciente* berthed port side to Finucane Island berth D using a modified mooring arrangement because of construction work that was in progress on the adjacent berth.

At about 0230 on 12 September, when the ship was almost fully loaded with iron ore, the duty seaman noticed that the ship was about one metre off the wharf forward and aft so he went forward to tighten the headlines. At about the same time, the chief mate, who was on the wharf checking the ship's draught, noticed that the ship had moved forward and was about one metre out from the wharf so he instructed the second mate to go aft and check the ship's mooring lines.

When the second mate reached the aft mooring station, he could see the mooring lines jerking and paying out under load. At least one of the aft mooring lines had parted. He tried to tighten the mooring winch brakes but this seemed to have no effect. He went to the nearest shipboard telephone and called the master and then made an emergency announcement calling the ship's crew to their mooring stations.

At about 0245, the master went to the bridge and saw that the ship's stern was about 30 m off the wharf. He called harbour control and reported that the ship was 'falling off the wharf' and that he needed immediate assistance. Harbour control immediately contacted the local tug operator, then called the duty pilot and the harbour master.

By 0255, two workboats that were working in the harbour had attempted to push *Creciente*'s stern back towards the wharf before the harbour tugs became available.

The master called the chief engineer and requested the use of the main engine as soon as possible. Within four minutes the bridge was given control of the main engine and the master ran the main engine in an unsuccessful attempt to move the ship's stern back towards the wharf.

At about 0310, despite the efforts of one tug and the workboats, *Creciente*'s stern probably made contact with the side of the channel opposite the wharf, causing the rudder to jam hard over to port until it was freed at about 0340.

At about 0324, a pilot boarded *Creciente* and began using the ship's engine and the two tugs that had arrived to prevent the ship from grounding again and return it to its berth.

At about 0434, the harbour master informed the pilot that, in about 20 minutes, he would have no under keel clearance as the tide was still ebbing. He instructed the pilot to move the ship to the deepest part of the channel and hold it there using the ship's engine and the tugs until later in the morning, when the tide had risen.

---

1 Dimensions larger than those allowable for transit of the Panama Canal.

2 All times referred to in this report are local time, Coordinated Universal Time (UTC) + 8 hours.

At about 0515, the rudder again became stuck hard over to port and, by about 0615, the ship's engine was stopped because the ship was hard aground and could not be moved back into the centre of the channel.

At about 0724, the tide began to flood and the tugs continued to hold the ship in position until it refloated at 0947. *Creciente* transited the channel without any further incident and, at 1430, anchored outside the harbour.

An underwater damage assessment revealed that the rudder was cracked, the rudder stock was twisted, four of the five propeller blades were bent, and some of the ship's bottom and side plating was set in by as much as 300 mm in places.

At 1305 on 30 September, *Creciente* departed from the Port Hedland anchorage, with the tug *Seiha Maru No 2* in attendance, bound for Kashima, Japan.

The investigation determined that the modified mooring arrangement is unlikely to have contributed to the incident. The report identifies the following safety issues and issues two recommendations and five safety advisory notices to address them:

- The additional layers of mooring rope stored on the mooring winch drums effectively reduced the holding power of the winch brakes, which caused the brakes to slip at below their designed holding capacity.
- The winch brake drums had not been effectively maintained, being heavily pitted and generally in poor condition, which further decreased the brakes holding capacity.
- Many of the mooring winch brakes were probably not fully applied which allowed the brakes to slip more easily.
- The mooring lines were not monitored effectively in the period leading up to the incident, which allowed the ship to move away from the wharf, because insufficient manpower was utilised for the task.
- *Creciente* did not have any guidelines or procedures for mooring the ship. Consequently, the master did not adequately assess the risks that the ship's mooring arrangement, and the likely winch brake condition, posed to the ship's ability to remain at its berth under the prevailing tidal conditions.
- *Creciente*'s classification society, Lloyd's Register, did not have rules or guidelines in place to ensure that the mooring winch brakes were adequately inspected and maintained, allowing the condition of the brakes to deteriorate and slip at below their designed holding capacity.
- The Port Hedland Port Authority did not identify the possibility of a ship breaking away from its berth and adequately assess or address the associated risks in the port emergency plan.

# 1 FACTUAL INFORMATION

## 1.1 *Creciente*

*Creciente* is a Hong Kong registered bulk carrier (Figure 1). At the time of the incident, it was owned by Triumph Sea, Hong Kong and managed by Eurasia International China, Hong Kong. The ship was classed with Lloyd's Register (LR).

The ship was built in 1989 by Mitsui Engineering and Ship Building, Japan. It is a conventional cape-sized bulk carrier with nine cargo holds located forward of the accommodation superstructure. It has an overall length of 270.0 m, a beam of 43.0 m, a depth of 24.1 m and a deadweight of 152 065 tonnes at its summer draught of 17.62 m.

Propulsive power is provided by a six cylinder MAN B&W 6S70 MC, single acting, direct reversing, two-stroke diesel engine delivering 16 400 kW. The main engine drives a single fixed pitch, right hand turning propeller to give the ship a service speed of about 14 knots[3].

**Figure 1: *Creciente* at anchor off Port Hedland**


At the time of the incident, the ship's crew consisted of 12 Indian, 16 Bangladeshi and one Pakistani national. The mates and engineers maintained a watchkeeping routine of four hours on, eight hours off while at sea. In port, the mates continued this routine while the engineers worked a twenty-four hour duty roster with the engine room unmanned outside normal daytime working hours.

The master held an Indian master's certificate of competency, which was first issued in 1975. He had 41 years seagoing experience, the last 29 years in command.

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

He had been master of *Creciente* for five months and was completing his first assignment on the ship. He had been to Port Hedland several times in the past.

The pilot who berthed *Creciente* on 10 September held an Australian master's certificate of competency and had started his pilotage career in 1981. He joined the Port Hedland Pilots in 1986. He had experience piloting all types of ships, including bulk carriers, and had piloted *Creciente* in the past.

The pilot who went on board *Creciente* after the breakaway on 12 September began his seagoing career in 1984. He held an Australian master's certificate of competency. He joined Port Hedland Pilots in 2001 and after twenty four months training and under-study time, he received his unrestricted pilotage licence. He had experience piloting all types of ships, including bulk carriers of a similar size to *Creciente*.

### 1.1.1 Mooring winches

*Creciente* has two windlasses and six mooring winches located on the forecastle deck. Two athwartships mounted mooring winches are located aft of the number two cargo hatch with two more located between number eight and number nine cargo hatches. Six mooring winches are located on the after deck, aft of the accommodation.

The winches and windlasses are hydraulically driven and fitted with a length of 65 mm diameter, double braided nylon mooring line that had a mean breaking strain of 90 tonnes when new. The windlasses have a heaving capacity of 40.5 tonnes and the winches a heaving capacity of 20 tonnes. None of the mooring winches are self-tensioning and each winch is fitted with a band brake with a specified maximum holding capacity of 67.6 tonnes.

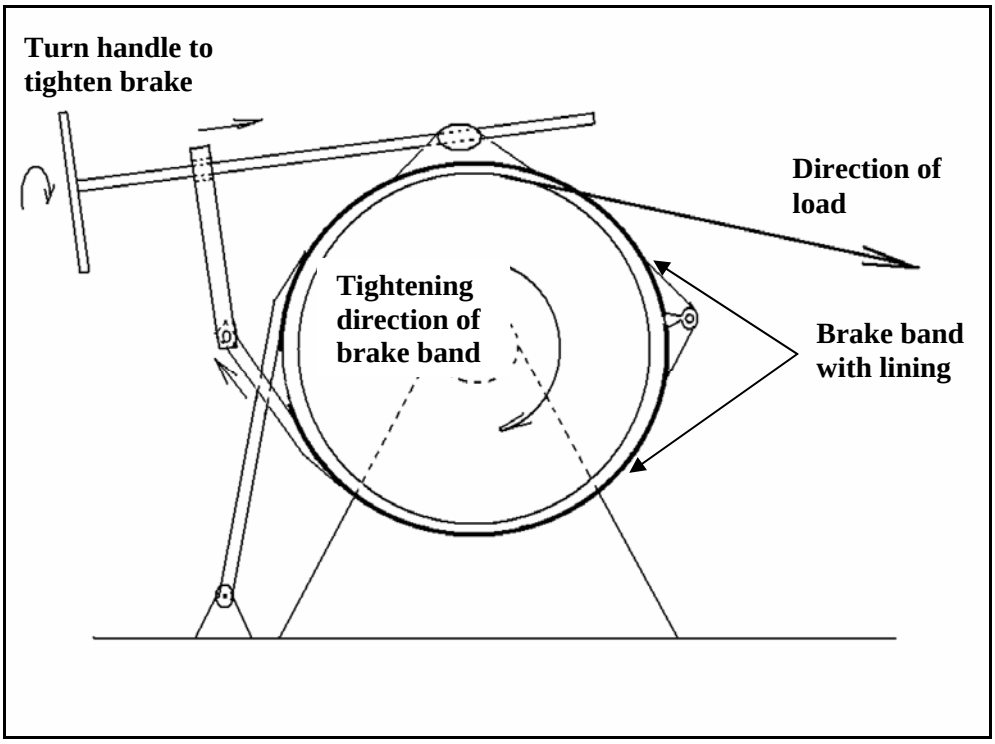
**Figure 2: *Creciente*'s aft breast line mooring winch**

Each mooring winch consists of two separate winch drums on a common shaft that is driven by a single hydraulic motor. Each drum can be connected to the shaft by way of a dog clutch (Figure 3) and has a separate band brake (Figure 4).

**Figure 3: Mooring winch dog clutch**

The brake on each mooring winch is designed to be tightened by turning the hand-wheel clockwise, as tightly as possible. The hand-wheel turns a screw that draws the ends of the brake bands together, which brings the brake lining into contact with the drum (Figure 4).

**Figure 4: Mooring winch band brake**



When mooring lines are correctly wound onto a winch drum, the tension on the line should be in the same direction as the tightening action of the brake band onto the drum, which assists the brake's operation[4]. In Figure 4, this is achieved when the mooring line pays out from the top of the drum as shown.

## 1.2 Port Hedland

Port Hedland (Figure 5) is a large bulk cargo export port located on the northwest coast of Western Australia. The port services the mineral rich eastern Pilbara region and its major export commodity is iron ore. In the year ending on 30 June 2006, over 110 million tonnes of cargo was loaded at the port.

**Figure 5: Satellite image of Port Hedland**


The Port Hedland Port Authority defines the port as:

> …all that piece of water within a radius of 10 miles[5] of Hunt Point Beacon (Beacon 47). This area is shown on chart AUS53 as the "Port Limit". To seaward of the port limit is the pilotage area, which extends out to sea a distance of 20 miles from Point Hunt[6].

The entrance to the harbour is bounded on the north-western side by Point Hunt, at the eastern side of Finucane Island and on the southeast side by Airey Point, a low inconspicuous point, 3.5 miles west of Cooke Point (Figure 5).

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4 Oil Companies International Marine Forum, 'Winch Brake Band Design Considerations Impacting on Reeling Direction', November 2006.

5 A nautical mile of 1852 m.

6 Description downloaded from the Port Hedland Port Authority website, http://www.phpa.com.au/.

A drying sand spit and spoil ground extends north from the foreshore nearby, and to the east of, Airey Point and east of the dredged channel. The inner part of this ground dries and acts as a breakwater during easterly winds.

Finucane Island is separated from the mainland by West Creek.

The port has two iron ore loading berths at Nelson point and another two at Finucane Island, all of which are owned and operated by BHP Billiton, and a number of general cargo wharves. There are also a number of prominent tanks, masts and towers charted on both sides of the entrance to the port.

The Port Hedland Port Authority, a statutory authority established under the *Western Australia Port Authority Act 1999*, manages the port and is responsible for the supply of all pilotage services. The Port Authority is governed by a board of directors, all of whom are appointed by the Minister for Planning and Infrastructure, who oversees the functions and policies of the Port Authority.

### 1.2.1 Tidal flow

Tidal information for Port Hedland is provided on navigational chart Aus 54, in the Australian Tide Tables and in the Australia Pilot[7].

The Finucane Island berth D lies in a 018° - 198° (T) direction and, according to the information printed on the navigational chart, the maximum ebb tidal flow adjacent to the berth occurs about two hours after a spring high tide and flows towards 020° (T) at 1.9 knots (Figure 6).

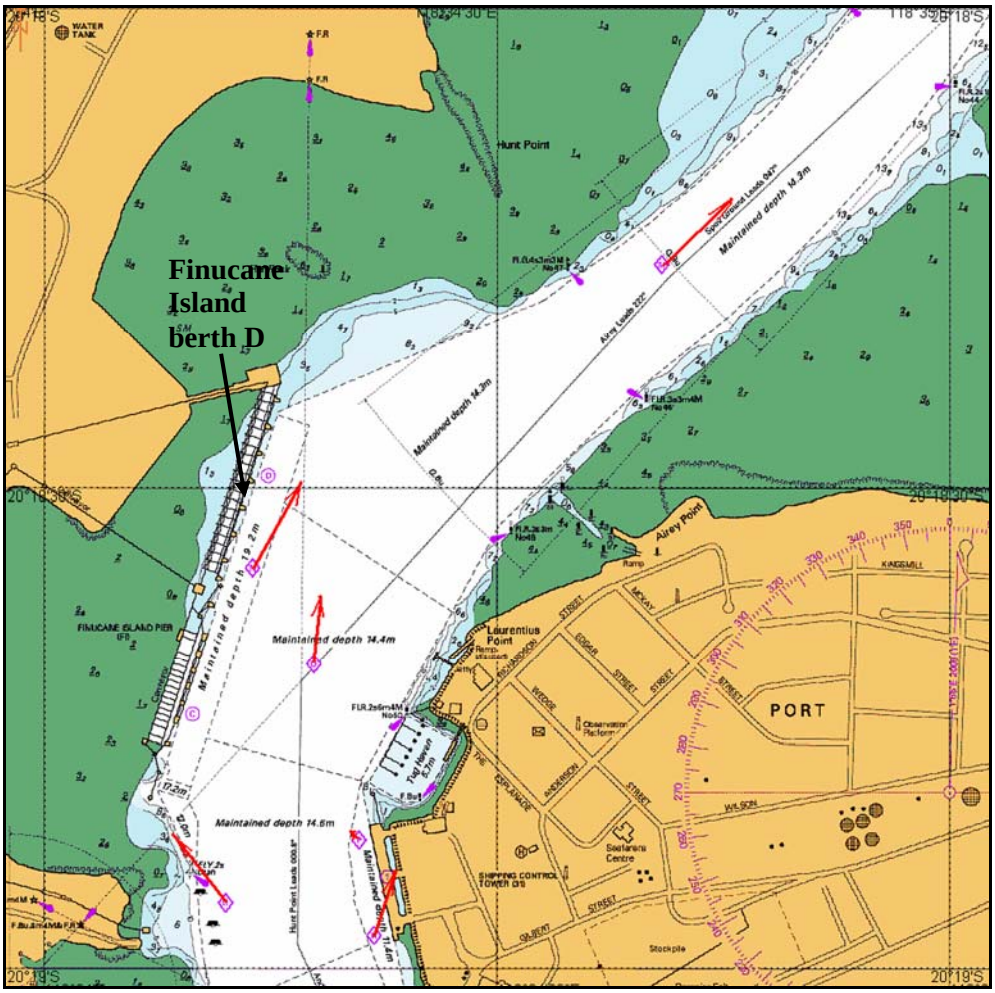
The predicted tides for September 2006, during *Creciente*'s stay in Port Hedland, are shown in Table 1.

**Table 1: Predicted Port Hedland tides for September 2006**

| Sun 10 | | Mon 11 | | Tues 12 | |
|---|---|---|---|---|---|
| **Time** | **Height (m)** | **Time** | **Height (m)** | **Time** | **Height (m)** |
| 0019 | 7.13 | 0050 | 7.27 | 0118 | 7.19 |
| 0618 | 0.16 | 0652 | 0.09 | 0724 | 0.29 |
| 1237 | 7.05 | 1310 | 6.89 | 1340 | 6.54 |
| 1832 | 0.26 | 1903 | 0.45 | 1932 | 0.84 |

7 Australia Pilot Volume I, Admiralty Sailing Directions NP 13, First Edition 2005.

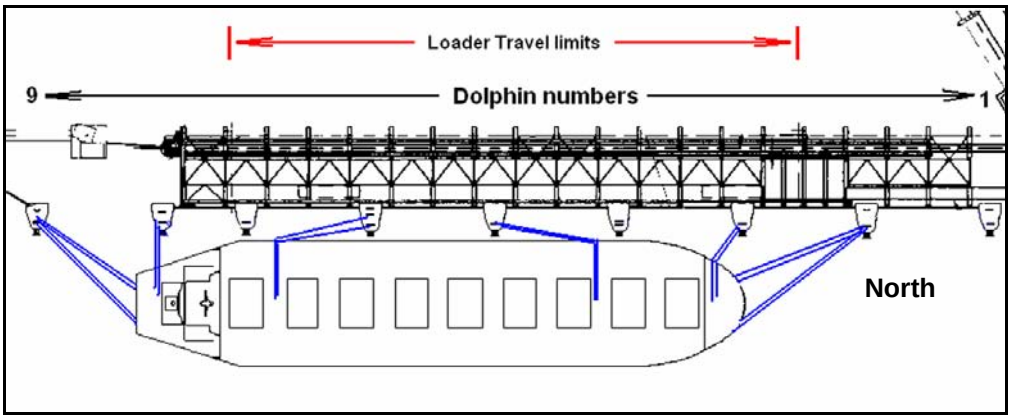
**Figure 6:** **Section of navigational chart Aus 54 with vectors indicating charted maximum tidal flows at different locations**




## 1.2.2 Finucane Island berth D mooring arrangements

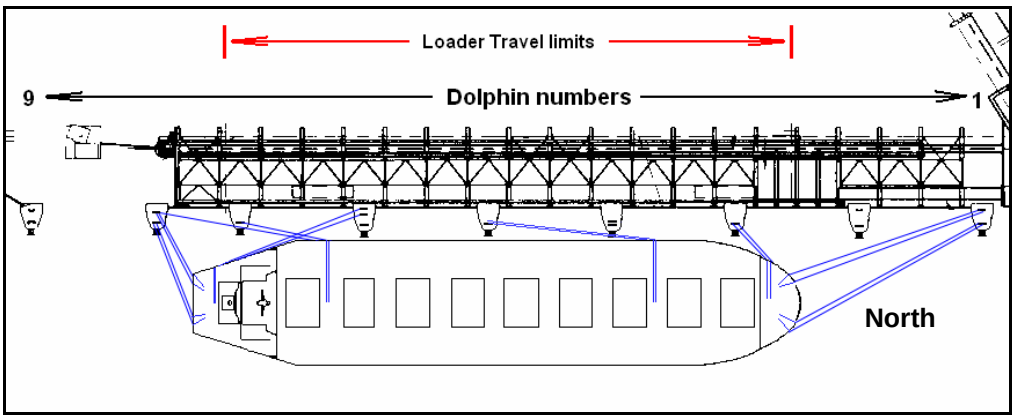
The usual mooring arrangement for a cape-sized ship, like *Creciente*, at Finucane Island berth D is for the ship to be located with the bridge marker approximately 12 m from the southern end of the wharf. The mooring lines would normally have consisted of four headlines run to number two mooring dolphin, two forward breast lines led to number three dolphin and two forward springs led to number five dolphin. Four stern lines would be run to number nine dolphin, two aft breast lines to number eight dolphin and the two aft springs to number six dolphin (Figure 7).

**Figure 7: Normal mooring arrangement at Finucane Island berth D**




However, on 10 September, a construction barge was being used to undertake modification work on the northern end of Finucane Island berth C, resulting in the number nine dolphin being inaccessible. As this had been a regular occurrence since May 2006, a revised mooring plan had been devised and implemented for ships using the berth (Figure 8).

**Figure 8: *Creciente*'s mooring arrangement at Finucane Island berth D**




Under the revised mooring plan, the ship's bridge marker was located about 45 m from the southern end of the wharf, about 30 m further north along the wharf. This provided an extra lead for the stern lines without the ship's position exceeding the travel limits for the loader.

The forward mooring lines were arranged as per the normal plan (Figure 7). However, the arrangement for the aft lines was different. Two breast lines were led from the outboard winches to number eight dolphin along with two from the inboard side of the aft deck. Two spring lines were made fast to number six dolphin. Two stern lines were run from forward of the accommodation. The original plan called for both of these to be run to number eight dolphin but on 10 September, one led to number seven dolphin and the other to number eight dolphin (Figure 8).

## 1.3 The incident

On the morning of 8 September 2006, *Creciente* arrived off Port Hedland after a voyage from Kokura, Japan and anchored off the port while waiting for the Finucane Island berth D to become available for the ship to load a cargo of about 150 000 tonnes of iron ore.

At 1450 on 10 September, a Port Hedland pilot boarded the ship for the transit from the anchorage to the berth. The pilot and the master discussed the pilotage passage plan and, during this information exchange, the pilot explained the modified mooring plan to the master.

The pilotage passage went as planned and the ship's first mooring line was ashore at 1620. The ship was moored according to the modified mooring plan (Figure 8) and, when it was in position, all mooring lines were made fast by applying the winch brakes. By 1730, the ship was all fast port side to the wharf.

As part of the normal practice on board the ship, the duty seaman was required to regularly check the position of the ship during cargo loading and to adjust the tension of the mooring lines as necessary. A copy of the predicted Port Hedland tides was posted at the top of the ship's gangway so that the duty seamen would know the state of the tide.

At 1820, the ship began loading its cargo. The loading was expected to finish in time for the ship to sail on the high tide at 2200 on 11 September. However, because of some delays ashore, the ship was rescheduled for departure at about 1100 on 12 September.

The weather on 11 September was generally fine and at midnight, there was a gentle northerly breeze of about 4 knots.

At midnight on 11 September, a draught surveyor attended the ship for the final stages of cargo loading. At 0100 on 12 September, loading was stopped while the surveyor and the chief mate checked the ship's draughts. The surveyor then calculated the final quantity of cargo required to bring the ship to its intended final draughts. He calculated that 1500 tonnes of cargo needed to be loaded into number eight cargo hold followed by 2100 tonnes into number two cargo hold.

After 0118, the tide began to ebb.

At about 0130, cargo loading resumed, according to the surveyor's plan. When there was about 700 tonnes of cargo left to be loaded into number two cargo hold, the chief mate and the surveyor went onto the wharf to monitor the ship's portside midships draught marks. The ship's draughts were 17.40 m forward, 17.56 m midships and 17.60 m aft. At the same time, the second mate climbed down the pilot ladder, which had been rigged on the starboard side of the ship, to check the ship's starboard midships draught. The surveyor then liaised with the cargo loader operator to ensure the ship was upright when cargo loading finished.

While the duty seaman was rigging lighting to illuminate the wharf area adjacent to the ship's port side midships draught marks, he noticed that the ship had moved off the wharf. He went forward, started the mooring winch hydraulic pump and engaged the winch motor to tension the forward breast lines. He then tensioned the head lines before returning aft.

At about the same time, the chief mate noticed that the ship had moved forward and was about one metre out from the wharf. He called the second mate, using his hand held radio, and told him to go aft and check the tension on the ship's mooring lines.

The second mate had left his hand held radio on the deck when he climbed down the pilot ladder, but he heard the chief mate's call. He climbed back up to the main deck, and responded to the chief mate, before going to the aft deck to check the aft mooring lines.

The second mate walked aft, along the starboard side of the ship. When he reached the aft deck, he could see the mooring lines jerking and paying out under extreme load. The winch brakes were not holding and were slipping, only occasionally gripping as they payed out. A great deal of smoke was being generated by the friction between the rotating brake drums and the brake linings. At least one of the mooring lines leading to number eight dolphin had parted.

The second mate tried to tighten the winch brakes but he could only tighten them a little and this seemed to have no effect. He went to the nearest shipboard telephone and called the master. He told the master that the ship was 'falling off the wharf' and that the mooring lines were slipping. He then called the third mate and the boatswain, before using the telephone to make an emergency announcement over the ship's public address system. He told all of the ship's crew to go immediately to their mooring stations.

It was about 0245 when the master received the telephone call from the second mate. After the call, he rushed to the bridge and, when he arrived there, he could see that the ship was about 30 m off the wharf. He could also see smoke coming from the mooring winches located forward of number nine cargo hatch as they payed out.

In an attempt to halt the ship's forward movement, the master instructed the second mate to go forward and to let go the port anchor. At 0246, the master called harbour control and informed them that the ship was 'falling off the wharf' and that he needed immediate assistance. He then called the chief engineer and requested the use of the main engine as soon as possible.

Harbour control immediately contacted Teekay Shipping, the port's tug operator, and then called the duty pilot and the harbour master. Harbour control also asked if the workboats operating in the harbour could assist.

At 0250, the bridge was given control of the main engine and the master ran the main engine astern in an attempt to move the ship's stern back towards the wharf. However, the ship continued to swing away from the wharf.

The duty seaman had also noticed that the ship was moving forward, so he ran to the aft mooring station. As he arrived at the aft mooring station, he heard the second mate broadcasting the emergency call. He started the aft mooring winch hydraulic unit and tried to tighten the stern lines, but he could not tighten them. He then tried to tighten the breast lines but he could not tighten them either.

The third mate and boatswain then joined the duty seaman at the aft mooring station. The three men stood well clear of the lines and watched as each of the aft mooring lines either parted or ran out until there was nothing left on the winch drum.

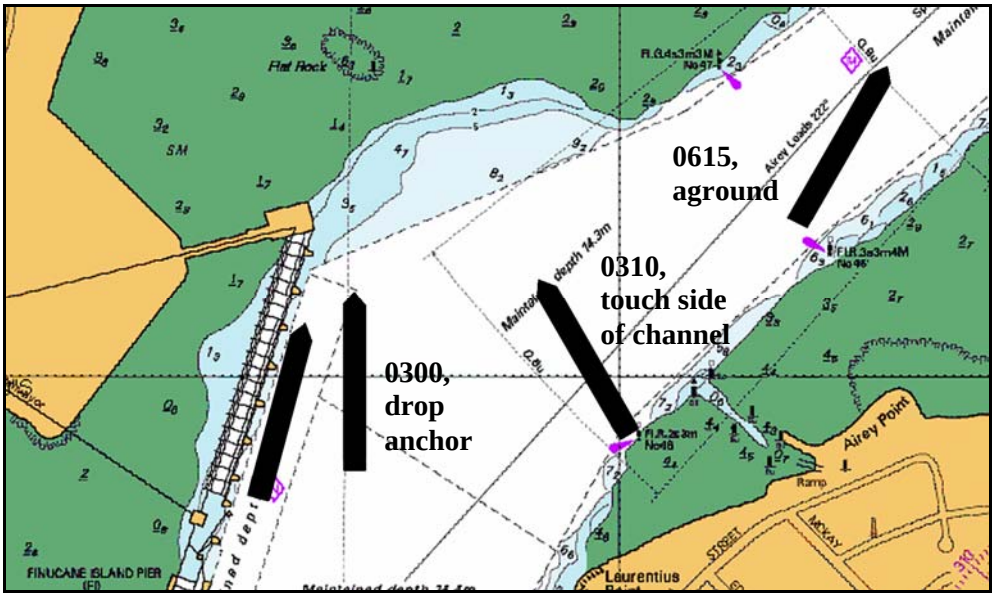
By 0255, two workboats, *Sentinel* and *DN57,* had arrived to assist *Creciente*. The workboats attempted, unsuccessfully, to push *Creciente*'s stern against the tide and back towards the wharf.

When the second mate arrived on the forecastle, he could see that the forward mooring lines were paying out and smoke was coming from the winch brakes. At first, he felt that it was too dangerous for him to move towards the port windlass to let go the port anchor. However, after pausing momentarily, he made his way to the windlass and let go the anchor. At about 0300, the second mate reported to the master that the port anchor had been let go. The anchor was lowered until there

were three shackles in the water. The ship's stern was now about 50 m off the wharf and the two aft spring lines had also parted.

At 0300, *Sentinel*'s skipper called *Creciente*'s master on the VHF radio and informed him that the ship's stern was close to grounding on the starboard side. *Sentinel* then moved further forward along *Creciente*'s hull because there was insufficient water available for the workboat to safely manoeuvre. The master briefly ran the ship's engine ahead in an attempt to keep the stern clear before resuming his attempt to move the ship astern towards the berth.

**Figure 9:** **Section of navigational chart Aus 54 showing *Creciente*'s approximate movement inside Port Hedland harbour**




At 0310, the first tug, *Indee*, left its mooring and went to assist *Creciente*. The tug began pushing on the starboard midships section of the ship in an attempt to push it back into the channel. At about the same time, *Creciente*'s master realised that the ship's rudder was stuck hard over to port (Figure 9). At about 0314, *Creciente* was moving back into the channel and the master ordered the anchor to be recovered.

By 0318, the ship had passed the centreline of the channel and the master ran the engine astern in an attempt to keep the ship's port bow from grounding.

At 0322, a second tug, *Turner*, arrived to assist At about the same time, a pilot was transferred from *Sentinel* to *Creciente*. The pilot boarded via the starboard gangway and immediately made his way to the bridge. He then began using the ship's engine and the available tugs in an attempt to prevent the ship from grounding.

At about 0330, two more tugs, *Boodari* and *Corunna*, left their berths and came to assist. Despite now having four tugs to assist, the pilot called harbour control on the VHF radio and reported that he was struggling to keep the ship from grounding. He requested more tugs be despatched to assist.

At about 0340, the ship's rudder came free and it was brought back to midships.

At 0344, the pilot contacted harbour control to discuss the options available to him. The tide was falling and there was insufficient water to take the ship out to sea through the channel. Furthermore, the ship would need to be back alongside before 0430 or it would need to hold its position in the deeper section of the channel until after 1045 when sufficient water would be available.

**Figure 10:** ***Creciente*** **aground in Port Hedland**

At 0347, *Creciente*'s bridge was abeam of beacon number 47 but the ship was struggling to make any sternway against the tidal flow. The pilot continued trying to manoeuvre the ship back to the wharf.

At 0400, *Pardoo*, the fifth tug to assist, left its berth and, at 0423, it was joined by the tug *Sea Tiger*.

At about 0434, the harbour master called the pilot and informed him that in about 20 minutes he would have no under keel clearance. The pilot thought that the ship was making progress back towards the wharf and that he could still re-berth it. The harbour master informed him that it was too risky to continue. The pilot was instructed to move the ship to the deepest part of the channel and hold it there using the ship's engine and the tugs until the tide had risen sufficiently, later in the morning.

At about 0513, *Sentinel* took soundings around the ship. The water depth was 16.8 m near the port bow and 19.5 m near midships on the port side. *Sentinel* was unable to take soundings astern because there was insufficient room for the boat to manoeuvre due to the ship's proximity to the bank.

At about 0515, *Creciente*'s rudder again became stuck hard over to port.

At 0525, the rudder came free once again and the pilot continued to attempt to bring the ship into the deep water in the centre of the channel.

At 0543, a second pilot boarded the ship to assist. His role was to provide advice to the other pilot and to share the workload.

At 0615, *Creciente*'s engine was stopped when the ship stopped moving back towards the centre of the channel. The ship's forward draught was now 16.4 m and its bow was not in the middle of the channel where there was deep water. The ship's stern was 10 m away from beacon number 46, on a line between 46 and 47 beacons (Figures 9, 10 and 16). The ship's heading was 029° (T).

At 0625, *Mallina*, the seventh and final tug available, left its berth and headed towards *Creciente*.

At about 0724, the tide began to flood and, at about 0910, *Creciente*'s engineers checked and turned the ship's main engine using the turning gear. The tugs continued to hold the ship in position until it refloated at 0947. At 0953, the ship's

steering was tested. *Creciente* was then able to transit the channel without any further incident and at 1430, it anchored about 20 miles north of Point Hunt, in position 19° 54.9’S, 118° 26.3’E.

An underwater assessment of the damage to the ship revealed that the rudder was cracked and the rudder stock appeared to be twisted by about six degrees to port. Four of the five propeller blades were bent, three to forward and one to aft. The side plating was set in by as much as 300 mm in way of number two starboard, number three port and number four starboard water ballast tanks and the bottom stiffeners were set up by about 100 mm.

Lloyd’s Register issued a condition of class for the ship, based upon the underwater damage assessment, which stated that the ship would need to be escorted to dry-dock. At 1305 on 30 September, *Creciente* departed from the Port Hedland anchorage, with the tug *Seiha Maru No 2* in attendance, bound for Kashima, Japan, to discharge its cargo prior to docking.

# 2 ANALYSIS

## 2.1 Evidence

On 15 and 16 September 2006, investigators from the Australian Transport Safety Bureau (ATSB) attended *Creciente* while it was at anchor off Port Hedland. The master and directly involved crew members were interviewed and they provided accounts of the incident. Copies of relevant documents were obtained, including log book entries, statutory certificates, maintenance records, procedures and permits.

Information relating to the incident was also obtained from the Port Hedland Port Authority and the Port Hedland pilots. The draught surveyor, the harbour master and the involved port pilots were also interviewed.

## 2.2 Breakaway

At about 0245 on 12 September 2006, *Creciente*'s mooring lines failed to hold the ship alongside the wharf against a strong ebb tide, which resulted in the ship breaking away from its berth.

### 2.2.1 Mooring arrangements

Construction work was being undertaken on the Finucane Island berth C and a construction barge was positioned close to the berth D number nine berthing dolphin. To facilitate this, the mooring arrangements for all ships using berth D were changed from the usual configuration and the new arrangement (Figure 8) was assessed as equivalent and acceptable by the port pilots.

The effective static load holding capacities of *Creciente*'s mooring lines was calculated by the ATSB investigators for the normal berth D mooring arrangement and compared with the modified arrangement that was used on 10 September 2006. For this comparison, the pitting on the brake drums was disregarded and the brakes were assumed to have been applied by tightening fully. The calculations considered the length of each mooring line and the number of layers of unused line remaining on each winch drum.

The total athwartships holding capacity using the normal mooring arrangement was calculated to be 181.2 tonnes and the static load holding capacity in the fore and aft direction was 642 tonnes. The modified mooring arrangement had a total athwartships holding capacity of 211.0 tonnes and a fore and aft capacity of 611.9 tonnes.

The modified mooring arrangement provided greater holding athwartships at the expense of some holding capacity in the fore and aft direction. The comparison indicates that the modified mooring arrangement is unlikely to have contributed to *Creciente*'s stern breaking away from the berth.

### 2.2.2 Winch brakes

Of the sixteen lines used to hold *Creciente* alongside Finucane Island berth D, four of the aft mooring lines parted when the ship broke away from the berth; two

springs, one breast line and a stern line. The remaining aft lines and all of the forward lines had run off their drums. The broken lines indicate that the winch brakes had held whereas the unbroken lines indicate that the brakes had not.

A review of the ship's maintenance records for the mooring ropes revealed that two of the parted lines were recorded as being damaged and the other two would have required replacement within the next year.

An examination of the winch brake linings, and a review of the ship's maintenance records, revealed that the brake linings were not excessively worn and were still serviceable. However, the examination of the brake drums revealed that they were corroded and pitted (Figure 11) and that some of the brake band hinges were frozen with rust and paint, indicating a lack of maintenance (Figure 12).

**Figure 11: Corroded winch brake drum**

**Figure 12: Frozen brake band hinge pin**

The pitting and corrosion would have reduced the contact area between the brake lining and the brake drum metal face which would have reduced the brake's effectiveness. The worst brake drum (Figure 11) was on the forward breast line winch's aft drum and this brake's effectiveness was estimated to be about 40 per cent. The best brakes examined probably had an effectiveness of about 70 per cent

The frozen hinge pin (Figure 12) would probably have prevented the brake linings from having an evenly distributed contact with the metal face of the brake drum, allowing only the areas opposite the hinge to effectively contact the drum. This would have reduced the frozen winch brake's effectiveness by approximately another 50 per cent. There were four winch brakes with frozen hinge pins and most of the others showed some signs of corrosion and lack of maintenance.

In the preceding two years, shipboard maintenance records indicated that most of the winch brake drums had been cleaned, ground and wire-brushed before fitting new brake linings. The records indicated that all of the headline winch brakes were overhauled in July 2005, the forward breast line winch brakes in November 2004, the stern line winches on the aft deck and the aft spring winches forward of number nine hatch in April 2005 and the aft deck forward breast line brake in August 2006. The other winches had not had their drums reconditioned but new brake linings had been fitted in mid 2004. The shipboard maintenance records also indicated that the

holding capacity of the ship's winch brakes had been satisfactorily tested in April 2005.

The use of a powered wire brush or needle gun to clean the brake drum would have removed the surface rust and scale but would have had limited effect on improving the contact area between the brake drum and the brake lining because of the depth of the pitting. The grinding of the surface following de-scaling would have served to flatten out the indentations and pitting on the surface but would not have provided a uniform contact surface for the whole brake lining.

On 6 August 2006, the Australian Maritime Safety Authority (AMSA) conducted a port state control (PSC) inspection on board *Creciente* at Port Walcott, Western Australia. At the time, the surveyor found three defects, two concerning the fire fighting equipment and one relating to a worn mooring line forward. The mooring line was replaced and the other defects rectified. A PSC inspection is not a detailed examination of every item of equipment on board a ship but an overview of its condition. Corroded and pitted brake drums would not be readily visible to the inspector unless the brakes had been disassembled for inspection or maintenance. Consequently, a PSC inspection would not normally detect the worn and damaged brake drums.

The Lloyd's Register (LR) rules for annual survey include the anchor windlasses and mooring winches which are 'required to be examined so far as is practicable'[8] during each annual survey. Given that the condition of the brakes could not be seen unless they were at least partially disassembled for inspection, the inspection of the winch brakes 'as far as is practicable' would not reveal the condition of the brake drums. The mooring winch brake linings and brake drums were not listed as part of the continuous machinery survey routine required by LR. Consequently, the LR rules did not ensure that the brakes were effectively maintained.

The evidence indicates that the maintenance of the winch brake drums on board *Creciente* had been ineffective in that it did not adequately address the pitting and corrosion of the drums or the frozen hinge pins. As a result, the effectiveness of the brakes had been severely compromised, allowing the brakes to slip more readily which contributed to the ship's breakaway from its berth on 12 September 2006.

### 2.2.3 Winch drums

*Creciente* was fitted with conventional mooring winches that did not have a split drum (Figure 13). With no split drum, all of the rope not required for mooring the ship was stored on the single drum and the layers of unused rope effectively increase the diameter of the drum (Figure 14). If a split drum is fitted, one side of the drum is used to provide tension on the mooring line and the excess rope is stored on the other side of the drum.

8 Lloyd's Register's Rules and Regulations for the Classification of Ships, Pt 1, Ch 3,2.2 Annual Surveys.

**Figure 13: Typical split winch drum**

**Figure 14: *Creciente*'s winch drum**

The mooring winch brake's holding capacity was specified in the ship's equipment manuals as 67.4 tonnes with one layer of mooring rope on the drum. As the number of layers increased, the effective holding power of the brake decreased due to the greater diameter that the mooring line load is acting upon. The brakes effectiveness can be simply calculated using the ratios of the effective diameters (Table 2).

All of *Creciente*'s mooring lines were originally 220 m long, the length of a standard coil of mooring rope, although some of them had subsequently been shortened due to damage. Consequently, given the distance from the winch drum to the mooring dolphins at Finucane Island berth D for each line, all of *Creciente*'s mooring lines had at least two layers of rope remaining on their winch drums. The four aft breast lines, leading to number eight and number seven dolphins, all had five layers of mooring line remaining on their drum, limiting the effectiveness of the winch brakes.

**Table 2: Effective holding capacity of brake due to extra layers on the drum.**

| Extra rope layers on drum | Brake holding capacity | Brake effectiveness |
|---|---|---|
| 1 | 56.6 tonnes | 84 % |
| 2 | 49.2 tonnes | 73 % |
| 3 | 43.1 tonnes | 64 % |
| 4 | 39.1 tonnes | 58 % |
| 5 | 35.0 tonnes | 52 % |

*Creciente*'s usual headline and stern line mooring winches, facing aft and forward respectively, had lines that payed off the drum in the direction that assisted with the operation of the brake, the correct lead (Figure 4). The athwartships mounted winches, the breast line winches forward and aft and the spring line winches located between the cargo hatches on the main deck, each had one drum paying out from the top and one from the bottom (Figure 2), whichever side of the ship was alongside the wharf. On each of these winches, one line worked against the winch

brake's strongest holding direction, thereby slightly reducing the effectiveness of four of the ship's winch brakes.

The holding capacity of *Creciente*'s winch brakes was reduced by the additional layers of mooring rope that were stowed on the conventional winch drum. In the case of four of the mooring winches, the lines were led from the bottom of the drum, effectively further reducing the holding power of the winch brake. *Creciente*'s winches were not designed or used to maximize the holding capacity of the brakes. This meant that the brakes were less able to withstand the strong ebb tide on 12 September 2006.

### 2.2.4 Tending mooring lines

The winches on board *Creciente* were not self tensioning so one of the routine tasks assigned to the seaman on each watch was to tend the sixteen mooring lines. This task required the seaman to check the state of every mooring line to ensure that it was tight enough and that the ship was in the correct position alongside the wharf.

Normal shipboard practice is for the duty seaman to regularly conduct a 'fire watch' and ship inspection. This includes checking the mooring lines and adjusting them as necessary. This type of shipboard check would be conducted, at the least, every two hours. The ship had remained alongside during the previous 24 hours and the crew would have experienced the large tidal range associated with the spring tide. This experience, coupled with good seamanship, should have drawn the attention of the crew to the need to tend the lines more frequently.

*Creciente*'s safety management system did not include procedures for tending the ship's mooring lines while the ship was alongside the wharf. Consequently, the ship's crew did not have any formal guidance for tending the ship's mooring lines or for allocating personnel for the task.

If the lines were too tight, the seaman was required to slacken them. After the tide turned at 0118 on 12 September, as the ship was being loaded on a falling tide, the lines would tend to slacken, allowing the ship to move away from the wharf. To counter this, the seaman needed to tighten the lines to ensure the ship remained alongside.

To tighten each mooring line, the seaman needed to go to each winch then:

- Start the hydraulic pump motor;
- Align the dog clutch so that he could engage the clutch on a winch drum;
- Release the drum's brake;
- Tension the line;
- Reapply the drum's brake;
- Disengage the drum's clutch and, as each hydraulic motor was driving two mooring winch drums;
- Align the dog clutch and engage the clutch on the other winch drum;
- Release the drum's brake;
- Tension the line;
- Reapply the drum's brake; and

- Stop the hydraulic pump motor.

This sequence of operations would probably take about five minutes for each winch. Given the distance between the winches, the overall task of tensioning all of the mooring lines once could take a single seaman up to one hour, without considering any delays or other tasks.

Given these facts, each mooring line was probably tended about every two hours or when the seaman was instructed to do so by the officer of the watch. In order to have the lines tended more frequently, more crew were required.

In the early hours of 12 September, *Creciente* was completing its loading as the tide began to ebb. Assuming that the average loading rate was about 5000 tonnes per hour and knowing the rate at which the height of tide decreased, it is possible to calculate the rate at which the mooring lines became slack. From 0200 until the breakaway at about 0245, the ship's deck height, relative to the wharf, would have lowered by about 1.1 m reducing the tension in each mooring line. This would have allowed the ship to move off the wharf by about 0.75 m, which is consistent with the ship being reported as about one metre off the wharf when the seaman went forward to tend the lines at about 0230.

In a similar incident on 27 June 1999, the oil tanker *ARCO Texas* was discharging at a refinery in Ferndale, Washington, USA. At about 1345, a combination of spring tidal current and wind overcame the holding capacity of the mooring winch brakes and the ship drifted off the wharf, causing the loading booms to be damaged and some oil to spill into the water.

The Washington State Department of Ecology investigated the incident[9] and made several recommendations that included the need for at least two qualified persons to be on duty on deck specifically dedicated to tending the ship's moorings. The report also recommended that changes be made to procedures for maintaining and testing the winch brakes.

In the conditions that were present at the time of the incident, *Creciente*'s mooring lines were not adequately tended as only one seaman had been allocated to the task. Consequently, the mooring lines became slack, allowing the ship's stern to move off the wharf and present an increasing area to the ebbing tidal flow. Furthermore, the ship's safety management system did not provide any guidance for the task.

### 2.2.5 Brake tightness

An inspection of the brakes after the breakaway revealed that most of the linings were not highly polished and were not scored. If the brakes had slipped under high load, the brake linings would show signs of damage such as being highly polished, worn and burnt. The condition of the brake drums would also be expected to cause scoring of the brake linings if they had slipped under load.

While the brakes were reported to be smoking during the breakaway from the wharf, the brake linings did not show significant signs of burning or scoring. The absence of this type of damage to many the brake linings indicates that it is probable that the brakes were not fully tightened at the time that the ship began to

9 Washington State Department of Ecology, Prevention Bulletin 01-02, *The Arco Texas*, November 2001.

move off the wharf and this resulted in these brakes slipping at less than their rated load.

### 2.2.6 Combination of brake factors

On 10 September, *Creciente* was berthed using 16 mooring lines, all of which were secured using the winch brakes. The ship was totally dependent upon the winch brakes to hold it alongside the wharf.

The mooring forces for each of the mooring lines can be calculated using the geometry of the ship's mooring arrangement. The effect of all of the limiting factors affecting *Creciente*'s winch brakes on 12 September can then be calculated (Table 3).

**Table 3: *Creciente*'s winch brake effective holding strength on 12 September**

| Mooring line | P - S holding capacity | F - A holding capacity | Overall holding effect | Max. brake capacity | Hinge effectiveness (estimate) | Drum area (as inspected) | Tight-ness (estimate) | Layer effect (Table 2) |
|---|---|---|---|---|---|---|---|---|
| Headline outboard | 6.6 | 26.5 | 27.3 | 67.4 | 100% | 60% | 80% | 84% |
| Headline outboard | 5.0 | 20.2 | 20.8 | 67.4 | 100% | 60% | 80% | 64% |
| Headline inboard | 6.7 | 19.7 | 20.8 | 67.4 | 100% | 60% | 80% | 64% |
| Headline inboard | 6.7 | 19.7 | 20.8 | 67.4 | 100% | 60% | 80% | 64% |
| Fwd Breast | 2.6 | 17.1 | 17.4 | 67.4 | 100% | 50% | 80% | 64% |
| Fwd Breast | 2.6 | 17.1 | 17.4 | 67.4 | 100% | 50% | 80% | 64% |
| Fwd Spring | 0.7 | 8.6 | 8.7 | 67.4 | 50% | 50% | 80% | 64% |
| Fwd Spring | 0.7 | 8.6 | 8.7 | 67.4 | 50% | 50% | 80% | 64% |
| **Total Fwd (tonnes)** | **31.6** | **137.4** | **141.9** | | | | | |
| Stern line (#7 dolphin) | 1.5 | 9.1 | 9.3 | 67.4 | 50% | 60% | 80% | 58% |
| Stern line (#8 dolphin) | 0.9 | 11.8 | 11.8 | 67.4 | 50% | 60% | 80% | 73% |
| Aft breast (outboard) | 16.4 | 10.6 | 19.6 | 67.4 | 100% | 70% | 80% | 52% |
| Aft breast (outboard) | 16.4 | 10.6 | 19.6 | 67.4 | 100% | 70% | 80% | 52% |
| Aft spring | 5.4 | 27.0 | 27.6 | 67.4 | 100% | 70% | 80% | 73% |
| Aft spring | 4.8 | 23.8 | 24.3 | 67.4 | 100% | 70% | 80% | 64% |
| Aft breast (inboard) | 12.6 | 10.9 | 16.8 | 67.4 | 100% | 60% | 80% | 52% |
| Aft breast (inboard) | 14.7 | 12.8 | 19.6 | 67.4 | 100% | 70% | 80% | 52% |
| **Total Aft (tonnes)** | **72.5** | **116.5** | **148.8** | | | | | |
| **Combined total (tonnes)** | **104.1** | **253.9** | **290.7** | | | | | |

For these calculations, the brakes were assumed to have an effective tightness of 80 per cent, although it could conceivably be lower. The drum area was estimated from an inspection of the brake drums and the hinge loss was estimated from the ability of the brake band to clamp onto the drum.

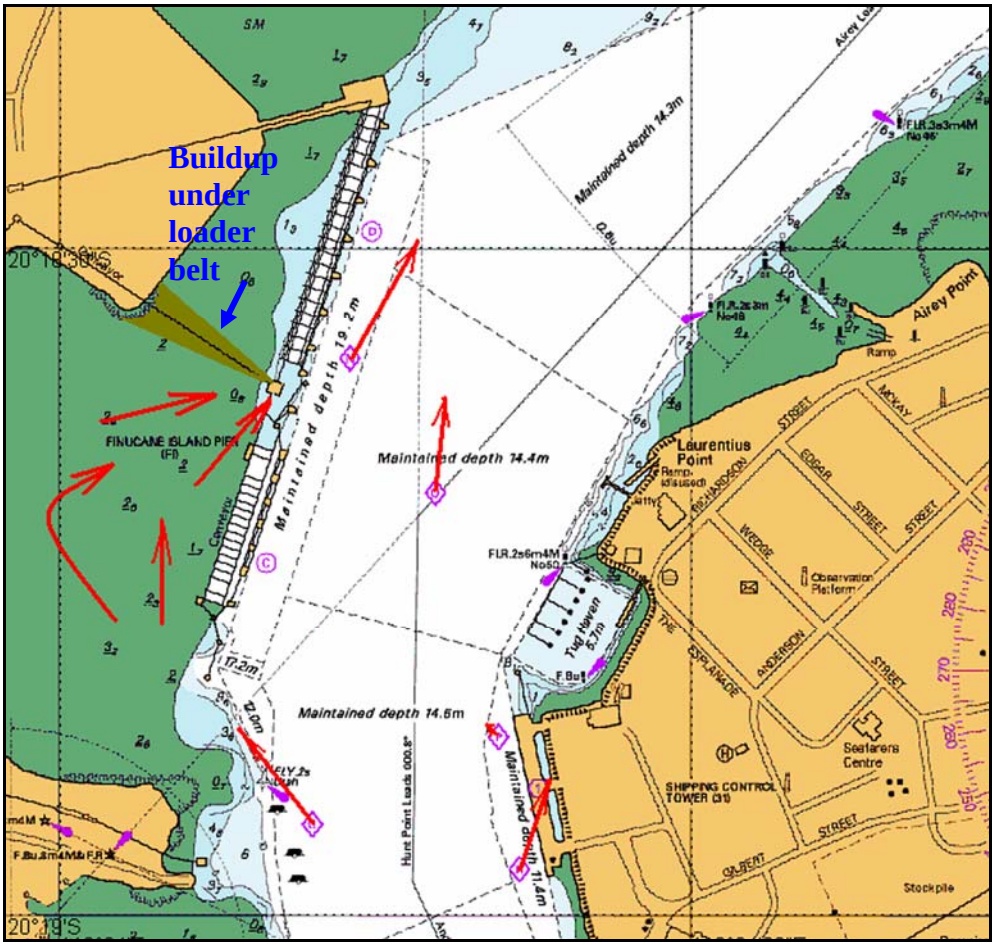
As can be seen from the table, the effective total athwartships holding capacity of *Creciente*'s winch brakes on 12 September 2006 was about 104 tonnes, far less than the 211 tonnes that was theoretically possible using the modified mooring configuration (Section 2.2.1) and the aft winches only had an effective holding capacity of 72.5 tonnes.

### 2.2.7 Environmental forces

*Creciente*'s mooring winches were required to hold the ship alongside the wharf against the wind and tidal forces that were acting on the ship.

The size of the wind force acting on the exposed area of the ship's hull and superstructure can be calculated. Given that the wind in the early morning of 12 September was about four knots from the north, the maximum force from this wind would have been about 6 tonnes if the wind was acting directly on the ship's beam, which it was not. In this instance, with the ship laying on a heading of 018° (T), the wind had negligible effect on the ship.

**Figure 15: Tidal flow affected by build up under the loader belt**



The spring tides in Port Hedland are recorded as having a tidal range of up to about 7.2 m. The maximum ebb tidal flow of about 1.9 knots at Finucane Island berth D, listed on the navigational charts for Port Hedland, is directed away from the wharf by about two degrees and acts on the port quarter of a ship alongside the berth.

This tidal flow within the harbour was plotted in March 1998, as part of the planning for redevelopment within the port and was found to be consistent with the navigational chart data. However, since that time, iron ore has spilled from the belt feeding the ship loader on Finucane Island berth C and has accumulated in the water under the belt (Figure 15). This would have the effect of reducing the tidal water flow under the loader belt. The resultant water flow would probably be directed more towards the main harbour and at a greater angle than is represented on the navigational chart, possibly an angle of up to about 30 degrees to the wharf (Figure 15). Furthermore, to a ship alongside the wharf, the actual tidal flow may have been at up to 2.5 knots instead of the 1.9 knots indicated on the chart.

The size of the tidal forces that act on the ship's hull can be calculated using a formula that was provided with the ship's documentation:

$$\mathbf{F = 73.2 \times V^2 \times L \times D},$$

where V is the flow velocity of the tide, given in metres/second and reflecting the angle of the tidal flow to the stern, L is the ship's length (270 m) and D is the ship's draught (17.6 m). The results are shown in Table 4.

**Table 4: Stern mooring loads for different tidal flows and angles**

| | **Tidal flow angle to stern (degrees)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Tidal flow (knots)** | **15** | **18** | **21** | **24** | **27** | **30** | **33** | **36** |
| **1.70** | 34.4 | 41.0 | 47.6 | 54.0 | 60.3 | 66.4 | 72.3 | 78.0 |
| **1.80** | 38.5 | 46.0 | 53.3 | 60.5 | 67.6 | 74.4 | 81.0 | 87.5 |
| **1.90** | 42.9 | 51.2 | 59.4 | 67.4 | 75.3 | 82.9 | 90.3 | 97.5 |
| **2.00** | 47.6 | 56.8 | 65.8 | 74.7 | 83.4 | 91.9 | 100.1 | 108.0 |
| **2.10** | 52.4 | 62.6 | 72.6 | 82.4 | 92.0 | 101.3 | 110.3 | 119.1 |
| **2.20** | 57.5 | 68.7 | 79.7 | 90.4 | 100.9 | 111.2 | 121.1 | 130.7 |
| **2.30** | 62.9 | 75.1 | 87.1 | 98.8 | 110.3 | 121.5 | 132.3 | 142.8 |
| **2.40** | 68.5 | 81.8 | 94.8 | 107.6 | 120.1 | 132.3 | 144.1 | 155.5 |
| **2.50** | 74.3 | 88.7 | 102.9 | 116.8 | 130.3 | 143.5 | 156.3 | 168.7 |

The ship's stern broke away from the wharf first. While the stern was exposed to approximately half of the tidal force and the aft winches were in better condition than the forward winches (Table 3), they only had an effective holding capacity of about 72 tonnes. As can be interpreted from the above table of loads for different tidal forces, *Creciente*'s aft winch brakes would not have been able to hold the ship's stern against the wharf in the ebb tidal stream of about 1.9 knots if it was at an angle of more than about 26 degrees to the stern. If the tidal flow was faster, the angle at the stern would have been less.

As the ship's stern came away from the wharf, the ship's angle to the tide increased, causing the ship to breakaway from the wharf more easily and more rapidly. As the

tidal force began to act on the whole of the ship's hull, the forward winches would not have been able to withstand the additional load. Furthermore, as each winch brake slipped or mooring line parted, the ship's ability to resist the force of the tidal flow progressively decreased.

The evidence shows that on 12 September, the spring tidal forces acting on the fully laden ship's hull were not greater than the designed holding capacity of the ship's mooring winch brakes but were greater than the effective holding capacity of the brakes at that time.

It is impossible to determine what initiated the breakaway from the wharf. However, the duty seaman tightened the forward mooring lines because the ship was about one to two metres off the wharf. This would have increased the angle that the ship presented to the tidal flow by about 0.3°. While normally insignificant, it may have been sufficient to initiate the breakaway in this instance.

## 2.3 Grounding

After *Creciente* had broken away from its berth, there were limited options available to the ship's master and the port authorities to rectify the situation. Initially, there were two options considered, either return the ship to its berth or move it out to sea. The first reaction by the master was to arrest the ship's movement from the berth and get assistance from the port to return it to the berth.

At about 0314, it became apparent to *Creciente*'s master that the ship's rudder was stuck hard over to port. This occurred shortly after *Sentinel*'s skipper warned *Creciente*'s master that the ship was very close to the side of the channel. The ship probably made brief contact with the side of the channel at this time.

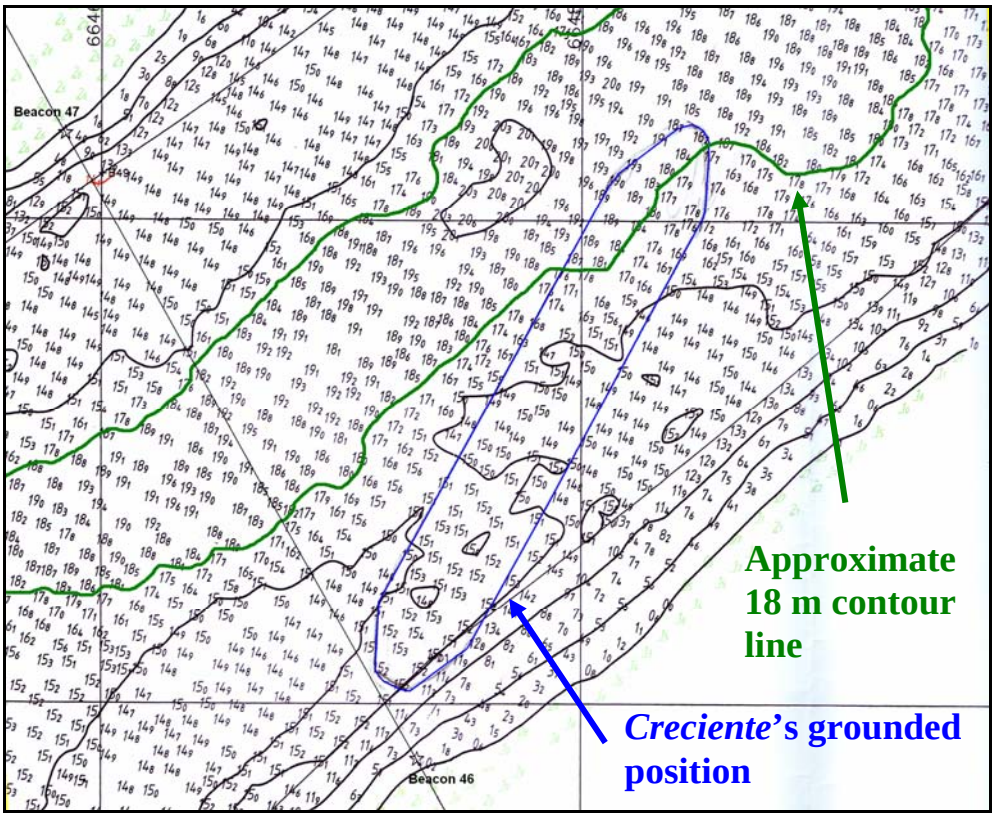
When the pilot arrived on board at about 0324 and assumed the conduct of the ship, the rudder was still stuck hard over to port and there were only two tugs in attendance. Since the tide was already over an hour and half into the ebb and the DUKC[10] sailing window had closed, he also attempted to return the ship to the berth.

The navigational chart (Aus 53) and the detailed hydrographic survey data for the port show that there was a pocket of deep water in the channel that could accommodate *Creciente*, without the ship grounding at low tide, with its stern between beacon numbers 46 and 47 (Figure 16). When *Creciente* could not be manoeuvred back to its berth against the receding tide, the harbour master made the decision to hold the ship in this pocket in the channel until the tide had flooded sufficiently for the ship to depart the port.

Despite the efforts of up to seven tugs and the ship's engine and rudder, the pilot could not hold *Creciente* in the designated deep water pocket against the strong tidal flow. At about 0515, the rudder became stuck hard over to port again. *Creciente*'s stern probably made contact with the bottom near beacon number 46 at this time as the tide receded and, by 0615, the ship was firmly aground. The tugs were unable to move it back into the deeper water. The ship had grounded adjacent to the deep water pocket in the channel (Figure 16).

10 Dynamic Under Keel Clearance (DUKC), a proprietary system for a real-time determination of the minimum under keel clearance of a ship transiting a channel.

**Figure 16:** **Port Hedland hydrographic survey data showing the deep water pocket and *Creciente*'s grounding position**




*Creciente* almost certainly touched the bottom twice. The first occasion was just after the breakaway, when the ship made brief contact with the side of the channel. The second grounding occurred at about 0515 when the ship grounded in the Port Hedland harbour channel, close to beacon number 46.

## 2.4 Risk Management

*Creciente* had berthed without incident at the Nelson Point iron ore berths in Port Hedland on several previous occasions. On each occasion, the ship had used the same configuration of 16 mooring lines that were tended as required by the duty seaman. This was the first time that the ship had berthed at Finucane Island berth D. The pilot informed the master of the seven metre tidal range associated with the spring tides and of the strong tidal flow that could be expected at the berth. The pilot also informed the master that the Port Hedland Port Authority (PHPA) required cape-sized ships berthed in Port Hedland to use 16 mooring lines and tend them regularly. No other mooring requirements were placed on the ship and these mooring requirements did not specifically identify the risks associated with mooring ships in the particularly strong tidal flow at Finucane Island berth D or the risk of a breakaway. Consequently, PHPA did not specify sufficient safeguards to reduce the risk of a fully laden ship breaking away from this berth in a full ebb tidal flow.

*Creciente's* crew had tended the ship's mooring lines throughout the previous 24 hours, while the ship had been affected by the high spring tides. This experience should have highlighted to them the difficulties and risks associated with a single seaman tending the lines through the night. Neither ship's master nor the duty

officers considered these issues and so, consequently, no action was taken to increase the manpower available for the task or to increase the frequency of tending the lines.

*Creciente*'s safety management system documentation did not include any guidance or procedures for mooring the ship, for tending the mooring lines or for assessing any risks associated with the task. Without such guidance, *Creciente*'s crew were not aware of, or did not consider, the reduction in mooring strength associated with the rope layering on the mooring winches. Furthermore, they did not adequately consider the reduction in brake effectiveness due to the corrosion and pitting of the brake drums. Consequently, the risks associated with mooring the ship at a wharf with an expected tidal range of about seven metres were not adequately assessed by the ship's crew.

When the Finucane Island berths were constructed by BHP Billiton, no analysis was undertaken, in conjunction with PHPA, of the impact that a build-up of material under the belts would have on the tidal flow or the effects of tidal forces on the ships that would use the berths. While ships have safely used these berths, anecdotal accounts from pilots berthing ships at them suggests that these berths are particularly susceptible to the effects of tidal forces.

The PHPA has a port emergency plan that states that it intends to cover foreseeable incidents and outlines remedial action but it is not designed to cover every eventuality[11]. The port emergency plan details the actions to be taken for several types of incidents such as fire and explosion, pollution, collision or stranding of a vessel. The port emergency plan does not list the breakaway of a ship from its mooring as a port emergency although an uncontrolled breakaway and the resultant blockage of the main shipping channel would constitute a significant port emergency.

Section C of the port emergency plan details the response to a 'vessel collision, sinking, stranding or emergency situation in Port Hedland harbour'. The stated aim of this section of the port emergency plan is to:

> … ensure, as far as possible, whatever the incident may be, that the dredged channel, turning basin, mooring basins and the recommended track in the approaches to the channel are kept free of obstruction to the safe navigation of vessels.

More detailed advice is included in this section of the plan under the heading 'Action by Pilots' which states:

> The pilot's overriding concern must be to keep the main shipping channel clear either by removing the vessel from the channel as speedily as possible if circumstances allow or by manoeuvring the vessel parallel and close to the channel edge.
>
> Every effort must be made to avoid impeding traffic flow and to remember that the port can still function, albeit in a restricted fashion, with channel width reduced to half.

Although the port emergency plan implies that if a ship grounds then it is preferable for it to occur, either outside the channel or close to and parallel to the channel edge, so as to not restrict the channel, it is generally preferable for a ship to not ground at all.

---

11 Port Hedland Port Authority (1999), '*Port Emergency Plan'*, p 3-1.

While the port emergency plan did not provide specific guidance for managing the breakaway of a ship from its berth, the harbour master took control of the incident, as required by the plan, and managed the risk that the breakaway posed to the port.

In this instance, the harbour master chose to attempt to prevent the ship from grounding by holding it in the deep water pocket in the channel. The ebb tidal flow proved to be too strong for the pilot to hold the ship in this position and the ship grounded in the channel, effectively blocking it.

When it became apparent that the ship could not be returned to its berth, the harbour master decided to hold it in the deepest section of the channel until the next flood tide. This was the only available option and, by holding the ship in deep water rather than continuing the attempt to re-berth it, the risk of an uncontrolled grounding in shallower water was minimised.

# 3 FINDINGS

## 3.1 Context

At about 0245 on 12 September 2006, the bulk carrier *Creciente* drifted off the Finucane Island berth D in Port Hedland, Western Australia. Four of its mooring lines parted with the remainder running off their winch drums. Up to seven tugs were used in an unsuccessful attempt to return the ship to the berth. The ship briefly made contact with the side of the channel at 0314 and was eventually held in the channel, where it grounded at about 0515. The ship was refloated on the next high tide and it departed the port under its own power.

From the evidence available, the following findings are made with respect to the breakaway and subsequent grounding of *Creciente* and should not be read as apportioning blame or liability to any particular organisation or individual.

## 3.2 Contributing safety factors

- All of the ship's mooring lines were secured using the winch brakes but the force of the spring ebb tidal flow on the ship's fully laden hull was greater than the winch brakes' ability to hold the ship alongside the wharf.
- The additional layers of mooring rope stored on the mooring winch drums effectively reduced the holding power of the winch brakes, which caused the brakes to slip at below their designed holding capacity. *[Safety issue]*
- The winch brake drums had not been effectively maintained, being heavily pitted and generally in poor condition, which further decreased the brakes holding capacity. *[Safety issue]*
- Many of the mooring winch brakes were probably not fully applied which allowed the brakes to slip more easily. *[Safety issue]*
- As each line parted or started to run out, the load on the remaining lines would have increased, causing the winch brakes to slip more readily.
- Once the ship began to swing off the berth, the ship would have presented a larger area of its hull to the tidal flow, which increased its effect on the ship.
- The mooring lines were not monitored effectively in the period leading up to the incident, which allowed the ship to move away from the wharf, because insufficient manpower was utilised for the task. *[Safety issue]*
- *Creciente* did not have any guidelines or procedures for mooring the ship. Consequently, the master did not adequately assess the risks that the ship's mooring arrangement, and the likely winch brake condition, posed to the ship's ability to remain at its berth under the prevailing tidal conditions. *[Safety issue]*
- *Creciente*'s classification society, Lloyd's Register, did not have rules or guidelines in place to ensure that the mooring winch brakes were adequately inspected and maintained, allowing the condition of the brakes to deteriorate and slip at below their designed holding capacity. *[Safety issue]*

## 3.3 Other safety factors

- The Port Hedland Port Authority did not identify the possibility of a ship breaking away from its berth and adequately assess or address the associated risks in the port emergency plan. *[Safety issue]*

## 3.4 Other key findings

- The modified mooring arrangement used at Finucane Island berth D is unlikely to have contributed to the ship's breakaway.
- The decision by the harbour master to hold *Creciente* in the deep water section of the channel was the best available strategy to manage the risk of the ship closing the port.

# 4 SAFETY ACTIONS

## 4.1 Safety action by the Port Hedland Port Authority

In response to this incident, the Port Hedland Port Authority issued a local marine notice that included[12]:

> Ships mooring lines are to be properly tended 24 hours per day whilst a vessel is moored alongside. Mooring lines are to be kept tight and the ship kept firmly alongside and parallel to the fender line.
>
> Mooring line arrangements are to be appropriate for the size of vessel.
>
> During Spring tide cycles where it is not possible for a single person to adjust all of the ships lines in a 15 minute period then two or more competent persons will be required to tend the mooring lines. Particular attention must be paid to ensure that self tensioning winches and mooring line drum brakes are properly set to hold the vessel alongside and to prevent it ranging along the wharf under the influence of the tide or vessel interaction forces.

## 4.2 ATSB recommendations

**MR20080007**

The Port Hedland Port Authority did not identify the possibility of a ship breaking away from its berth and adequately assess or address the associated risks in the port emergency plan.

The Australian Transport Safety Bureau recommends that the Port Hedland Port Authority takes action to address this safety issue.

**MR20080008**

*Creciente*'s classification society, Lloyd's Register, did not have rules or guidelines in place to ensure that the mooring winch brakes were adequately inspected and maintained, allowing the condition of the brakes to deteriorate and slip at below their designed holding capacity.

The Australian Transport Safety Bureau recommends that Lloyd's Register takes action to address this safety issue.

12 MN 05/06, 'Mooring Lines Port Hedland - Harbour Masters Direction'.

## 4.3 ATSB safety advisory notices

**MS20080010**

The additional layers of mooring rope stored on the mooring winch drums effectively reduced the holding power of the winch brakes, which caused the brakes to slip at below their designed holding capacity.

The Australian Transport Safety Bureau advises that ship owners, operators and masters should consider the safety implications of this safety issue and take action where considered appropriate.

**MS20080011**

The winch brake drums had not been effectively maintained, being heavily pitted and generally in poor condition, which further decreased the brakes holding capacity.

The Australian Transport Safety Bureau advises that ship owners, operators and masters should consider the safety implications of this safety issue and take action where considered appropriate.

**MS20080012**

The mooring lines were not monitored effectively in the period leading up to the incident, which allowed the ship to move away from the wharf, because insufficient manpower was utilised for the task.

The Australian Transport Safety Bureau advises that ship owners, operators and masters should consider the safety implications of this safety issue and take action where considered appropriate.

**MS20080013**

Many of the mooring winch brakes were probably not fully applied which allowed the brakes to slip more easily.

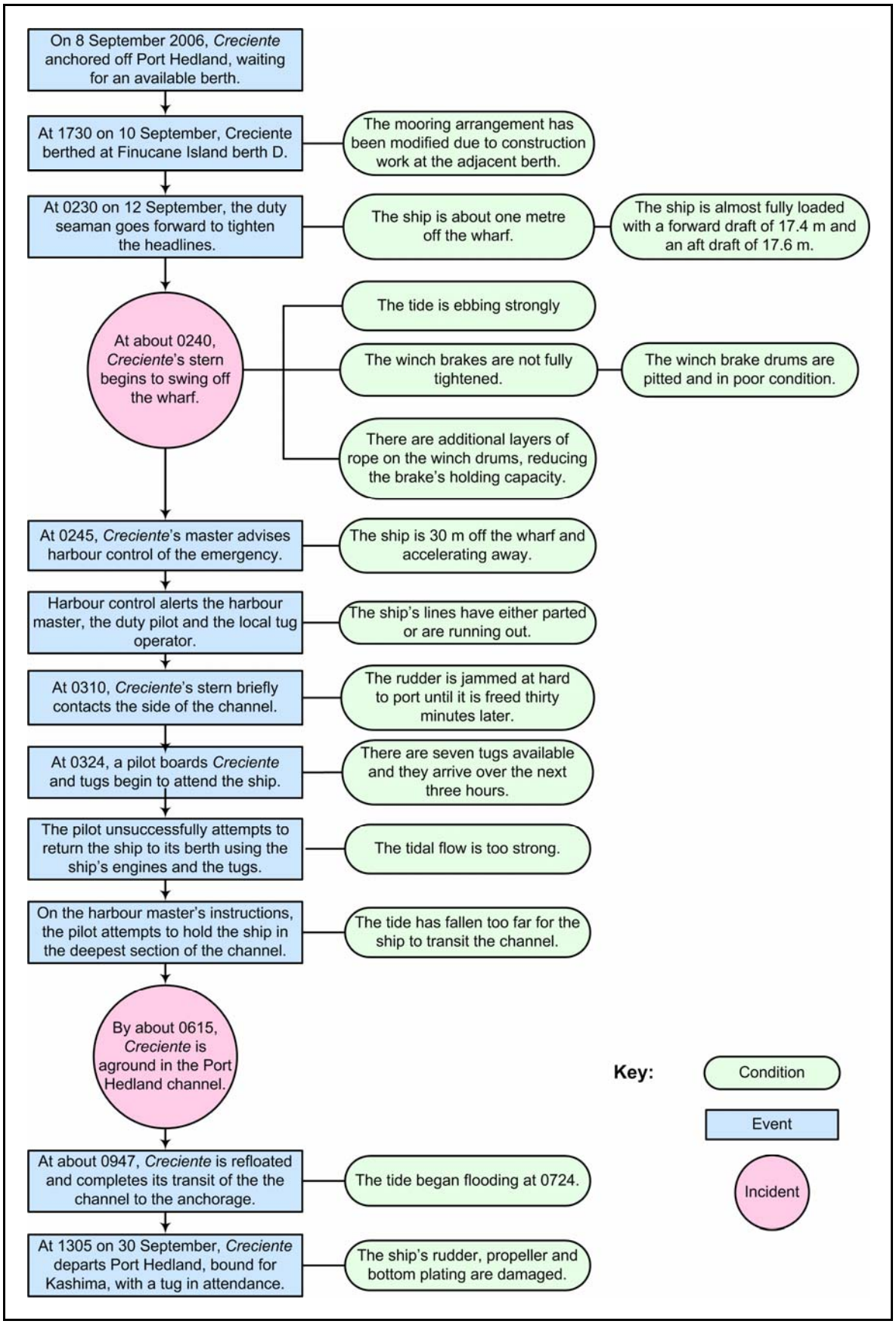
The Australian Transport Safety Bureau advises that ship owners, operators and masters should consider the safety implications of this safety issue and take action where considered appropriate.

**MS20080014**

*Creciente* did not have any guidelines or procedures for mooring the ship. Consequently, the master did not adequately assess the risks that the ship's mooring arrangement, and the likely winch brake condition, posed to the ship's ability to remain at its berth under the prevailing tidal conditions.

The Australian Transport Safety Bureau advises that ship owners, operators and masters should consider the safety implications of this safety issue and take action where considered appropriate.

# APPENDIX A: EVENTS AND CONDITIONS



# APPENDIX B: SHIP INFORMATION

## *Creciente*

| | |
|---|---|
| IMO Number | 8815463 |
| Call sign | VROI |
| Flag | Hong Kong |
| Port of Registry | Hong Kong |
| Classification society | Lloyd's Register |
| Ship Type | Bulk carrier |
| Builder | Mitsui Engineering and Ship Building |
| Year built | 1989 |
| Owners | Triumph Sea |
| Ship managers | Eurasia International |
| Gross tonnage | 77 655 |
| Deadweight (summer) | 152 065 tonnes |
| Summer draught | 17.62 m |
| Length overall | 270 m |
| Length between perpendiculars | 260 m |
| Moulded breadth | 43 m |
| Moulded depth | 24.1 m |
| Engine | Mitsui B&W 6S70 MC |
| Total power | 16 400 kW |
| Crew | 29 |

# APPENDIX C: SOURCES AND SUBMISSIONS

## Sources of information

Bureau of Meteorology

*Creciente*'s master and crew

Port Hedland Port Authority

Shipspotting.com

The draught surveyor

The Port Hedland harbour pilots

## References

Australia Pilot Volume I, Admiralty Sailing Directions NP 13, First Edition 2005.

Marine Notice MN 05/06, 'Mooring Lines Port Hedland - Harbour Masters Direction'.

Oil Companies International Marine Forum, 'Winch Brake Band Design Considerations Impacting on Reeling Direction', November 2006.

Port Hedland Port Authority (1999), '*Port Emergency Plan'*, as downloaded from www.phpa.com.au on 8 August 2007.

Prevention Bulletin 01-02, *The Arco Texas*, Washington State Department of Ecology, November 2001.

## 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 AMSA, the draught surveyor, the Port Hedland harbour master, Lloyd's Register of Shipping, both harbour pilots who attended the ship, *Creciente*'s master, the ship's managers and the Hong Kong Marine Department.

Submissions were received from Hong Kong, Lloyd's Register, both harbour pilots, the harbour master and the ship's managers and have been included and/or the text of the report was amended where appropriate.

Independent investigation into the breakaway and grounding of the Hong Kong registered bulk carrier *Creciente* at Port Hedland, Western Australia 12 September 2006.