Departmental investigation into the incident involving the Singapore flag cattle carrier CARABAO 1 in which the vessel dragged anchor, contacting the jetty and four moored vessels at the Western Australian port of Broome on 14 January 1998

Report No 129

Navigation Act 1912
Navigation (Marine Casualty) Regulations
investigation into the incident involving
the Singapore flag cattle carrier
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Summary

On 8 January 1998, the Singapore registered livestock carrier *Carabao 1* anchored with 3 shackles of cable about 240 m off the outer berth of the jetty, in the port of Broome in the north-west of Western Australia. The holding ground was considered to be good and the vessel lay securely at anchor to the tides and westerly winds that predominated over the next six days.

On 14 January, westerly winds of between 10 and 15 knots were experienced, dropping in the early evening to a gentle 5 knot westerly breeze. At about 2225, about one and half-hours before high water and with the ship lying to the tidal stream and heading north-east, a sudden squall was experienced at Broome generating storm force easterly winds. Within seconds *Carabao 1* started to drag anchor, directly toward the outer berth.

The Master, who was on watch, informed the engine room that he required the engine immediately, and called out the crew. The Chief Mate and Boatswain went forward to stand by the windlass.

At about 2228, the vessel's starboard bow, just aft of the anchor, came into contact with the eastern corner of the jetty. The vessel, drifting rapidly in a westerly direction, was then driven through the moorings of local fishing vessels. Four vessels were damaged, one of which broke from its moorings and was driven beneath the jetty by the wind and tide.

Between 2230 and 2235, the anchor held once more and *Carabao 1* came to a stop close to the shore. Soundings at the ship's stern showed that there was about one metre of water under the keel.

By 2245 the wind had dropped below 20 knots and the ship was able to recover its anchor at 2318 and move clear of the small craft moorings. By this time the wind had dropped completely away and *Carabao 1* anchored once more, 440 m off the outer berth.

Nobody was injured as a result of this incident. In addition to the four smaller vessels damaged, Broome jetty suffered some damage, *Carabao 1* sustained an isolated indentation to its hull plating forward and some superficial paint damage.

Sources of Information

The Master and crew of *Carabao 1*

The Pilot, Port of Broome

The General Manager, Port of Broome

The Bureau of Meteorology, Broome observation station

Western Australian Police Service, Broome

The Broome Volunteer Sea Search and Rescue Group

Members of the public fishing from the jetty at the time of the incident

The Bureau of Meteorology, Perth

The Australian Tidal facility, Flinders University

Acknowledgement

The Inspector gratefully acknowledges the assistance of the Officer in Charge, Broome Meteorological Observation Station.

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Narrative

General

Carabao 1 is a single hold livestock carrier of 1941.3 tonnes deadweight, with an overall length of 69.73 m, a beam of 13.21 m and a summer load draught of 5.312 m. Built in Haugesund, Norway, in 1974 as a general cargo/heavy lift ship primarily for the Baltic trade, the vessel is strengthened for ice and, as such, the hull is ideal for a trade where the vessel sits on the bottom in tidal rivers. The vessel is equipped with a magnetic compass, radar, GPS and echo sounder.

Main propulsion is by means of a 1394 kW Alpha diesel engine driving a single, variable pitch propeller in a fixed Kort nozzle, providing a service speed of 12 knots. The vessel is also equipped with a bow thruster. At the time of the incident, neither the bridge control of the variable pitch propeller nor the bow thruster had been functional for some considerable time.

The vessel was purchased by the present owner, Labroy Marine (Pte) Ltd of Singapore, in 1994 and was the second of three vessels purchased and converted for carrying cattle in the developing trade between northern Australian ports and the Archipelagic Islands to the north.

Carabao 1 is manned by a Filipino master and crew comprising two deck officers, three engineer officers, an electrical officer and eight ratings. An Australian stockman is also carried.

The Master and two deck officers maintain traditional four on eight off watches, with the Master keeping the 8 to 12 watch. The engine room is not equipped for unmanned machinery space operation and the three engineer officers maintain a similar watch system with the Chief Engineer keeping the 8 to 12 watch. At anchor, the engine room rating kept the evening watch from 2000, with the Chief Engineer supervising him and paying regular visits to the engine room.

Port of Broome

The Port of Broome is situated at the northern end of Roebuck Bay in the north-west of Western Australia. Ships berth at the end of an "L" shaped jetty 700 m in length. The port is capable of handling vessels of 187 m in length, which can berth on the outer side of the jetty, while smaller vessels can berth on the inner side of the jetty.

The area of water immediately off the berth is a prohibited anchorage, though vessels do anchor in this area under the Pilot's direction. The bottom is sand and is good holding ground. Large cruise ships and tankers have anchored in this area in strong winds and maintained their anchor positions without difficulty. Between the jetty and the north and east of the shoreline a number of moorings have been laid for local fishing and pearling vessels.

The port is visited about once a week by trading ships with gross tonnages in excess of 500. At night the port office is not manned and there is no scheduled radio station within VHF range, although the volunteer Coastwatch station is manned if required and in emergencies.

Broome has a large rise and fall in tidal height, with a maximum range of 10 m at spring tides.

Carabao 1, 23 December 1997 to 14 January 1998

Carabao 1 sailed from General Santos, a port on the Philippines island of Mindanao, on 23 December, with initial orders to return to Darwin. Bad weather and heavy seas forced the vessel to shelter in the Indonesian Archipelago and when the weather abated, the vessel was directed to Broome, Western Australia, to load livestock.

At 1006 on 7 January 1998, *Carabao 1* anchored off the fairway to Broome Harbour. The weather was fine but the wind was fresh to strong, force 5 to 6 on the Beaufort scale. The vessel had been at sea longer than anticipated and required stores and the opportunity to undertake some minor engine repairs. The distance from the port and the sea conditions at the exposed anchorage meant that stores could not be taken to the ship and the engine could not be shut down, even for a short period in the prevailing conditions.

The Master requested, through the charterers, that the vessel be allowed to anchor in the shelter of Broome Harbour. No other trading ship was due until the end of January and it was agreed that *Carabao 1* should be allowed to anchor in the harbour in what is normally a prohibited anchorage area.

On the afternoon of 8 January the Pilot boarded *Carabao 1* and took the vessel to an anchorage in the port. At 1816 the vessel was anchored using the port anchor with three shackles of cable in 11 m of water, about 240 m east of the outer end of the jetty. The Pilot made a particular point of ensuring that the cable was properly stretched.

The Master issued orders that the ship's position was to be carefully monitored and that if necessary, the engine was to be started. The officers were also to maintain a careful watch on the barometer.

On 8 January a further half shackle of cable, about 14 m, was paid out. Over the next few days, stores were taken on board, the crew prepared the ship for carriage of livestock and minor engine repairs were completed.

Carabao 1, 14 January 1998

The morning and evening of the 14 January proceeded routinely with anchor watches being maintained. The wind was from the west averaging about ten knots throughout the day, decreasing in the evening to a light breeze. Low water was at 1805 at 0.7 m above datum and high water at 2352 with a predicted height of 8.5 m. Sunset was at 1833, nautical twilight was at 1925 and there was a bright full moon which rose at 1938 that night.

At 2000, the anchor position was checked and the barometric pressure was recorded in the log as 1010 hPa. The wind was noted as variable force 4. The Master took over the anchor watch from the Mate. One of the deck ratings was also on watch covering the period 1800 to 2400. The oiler was on watch in the engine room, with the Chief Engineer on call in his cabin. The Chief Engineer visited the engine room every 20 to 30 minutes.

At 2045 the wind dropped to a light breeze and *Carabao 1* lay quietly to the flood tide in calm conditions. The ship's radar was operating mainly on the 1.5 mile range scale and the variable range marker was set on the outer end of the jetty.

At about 2225 the ship was hit without warning by a sudden, storm force easterly squall. The ship swung head to wind and the Master realised almost immediately that the ship was dragging its anchor. He ordered the seaman on watch to call the crew and rang the engine room to have the engine started. This phone call was immediately acknowledged by the engine room rating.

The Mate was on his way to the bridge when he met the seaman descending the short flight of stairs from the bridge and he returned to his cabin then went to the forecastle deck, where the Boatswain joined him. The Chief Engineer and Second Engineer went to the engine room immediately, where the Third Engineer and the Electrician joined them. The Second Mate, who had been asleep, dressed hurriedly and went to the bridge. Meanwhile, the ship drifted rapidly out of control, virtually port beam to the wind and with the starboard side towards the jetty.

After ordering the engine prepared for immediate use, the Master's initial reaction was to pay out more cable on the port anchor but, before the Mate and Boatswain could put the windlass into gear, the ship contacted the eastern end of the jetty, just aft of the starboard anchor. The time logged for striking the jetty was 2228. Striking the jetty did not arrest the ship's drift and *Carabao 1* was driven further west, through the moorings of fishing and pearling boats north of the jetty.

At 2230 the ship's engine was ready, but before manoeuvring, the Master sent the Second Mate and Rating aft to check that the ship was still afloat. At about this time the ship's anchor apparently dug in or fouled a mooring and the ship's progress was arrested. The wind speed at this time had decreased but remained strong.

The rating tied a weight to a heaving line to take soundings around the stern and measured the wet line in terms of the full span of his arms. By this method it was established that the vessel's stern was afloat. The Master then ordered dead slow ahead on the engine and started to try and recover the anchor. The engine was intermittently run at ahead pitch, dead slow and slow from 2235 until just after 2306, while the anchor was being recovered and the vessel was then manoeuvred back to the anchorage. The pitch was put dead slow astern at about 2313 for one minute, before being put to zero at about 2314. It remained at zero pitch until 2333 when finished with engine was rung.

That night, a number of people were fishing from the jetty. Four people were fishing from the outer end and, when the squall hit, they quickly gathered up their belongings with the aim of walking the length of the jetty to their car. As they did so, they looked up and saw the starboard side of the ship closing the end of the jetty with great rapidity. They could see low level lights in the cattle pens, some accommodation lights, the forward anchor light and an all round white light at the masthead. They saw the ship's starboard side strike the jetty and, although the accounts differ in detail, two of the witnesses thought that it was the bow area that had contacted the jetty initially.

The wind was so strong that they were unable to walk along the exposed jetty and they sought shelter on the lee side of the wharf shed. One of the party went to a phone booth at the end of the shed and

telephoned the police informing them that a ship had broken loose and had hit, and possibly sunk, vessels moored close to the jetty. The call was logged at the Police Station in Broome at 2235.

A police car with two officers, one of whom was a member of the Broome Volunteer Sea Search and Rescue Group, was just pulling into the Police Station and the officers were diverted to the port some 6 km away, where they arrived at about 2240. Initially they went to a car park at the western end of the jetty from where they could clearly see *Carabao 1* about 200 m to 300 m away and so close to the shore that it seemed to be aground. A local fishing vessel was also seen to have broken from its moorings and to have drifted under the jetty.

The Police alerted the General Manager of the Port, the Pilot and a member of the Volunteer Coastguard to the situation in the port and asked the latter to open up the volunteer radio station.

The General Manager arrived at the jetty at about 2250 and saw the vessel close inshore, apparently stopped in the water. The wind, although fresh, had reduced in intensity by this time.

The Pilot arrived a few minutes later and saw the ship with its navigation lights exhibited, apparently underway. He judged the ship was in dangerously shallow water and drove along the jetty to the Port office from where he called the ship on VHF Channel 16 at a time logged by the ship as 2256. He asked if the ship had its echo sounder switched on. The ship confirmed that the echo sounder was running and showed six meters under the keel. The Pilot advised the Master to anchor and await further orders, and the Master anchored 2.53 cables off the end of the jetty, using the port anchor and 4 shackles of cable. The Pilot spoke to the Master after the vessel was anchored and advised him to put out sufficient cable to prevent dragging. At about this time, the wind had died away and there was little or no breeze until later the following morning when light westerly airs were recorded.

The efforts of the Port personnel were then concentrated on extricating the fishing vessel from under the jetty, with the help of the Pilot boat and another craft. This was achieved at 0130 on 15 January, and three other boats believed to have been hit by *Carabao 1* were identified.

Comment and Analysis

Evidence

Carabao 1 was not equipped with any automatic recording device. Times of events were kept on board in bell or movement books. The Bridge Bell book was used to record times of significant events such as anchoring or pilot arrival and departure times. It was not used to record the time of engine (propeller pitch) movements. Times of engine movement orders were kept in an "Engine Room Movement Book".

Bridge records of this incident were extremely neat and it is hard to imagine that the writing would be so uniform if the entries were contemporaneous with events, given the urgency and stress prevailing on the bridge. The engine room movement book, however, appears to be a running record of the actual engine movements.

According to the bridge bell book, after *Carabao 1* had ceased dragging anchor, the vessel commenced weighing the port anchor at 2236, and at 2318, the anchor was logged as being 'up'. The next entry in the bridge bell book states that at 2328, the port anchor was dropped with 4 shackles in the water, 2.53 cables off the jetty in accordance with advice received from the Pilot.

The engine movement book indicates that the last engine movement was dead slow astern at 2313:15, and that the engine was stopped at 2314:15. There were no further engine movements that night, and this would suggest that the vessel anchored off the jetty at 2314, rather than at 2328.

There are inconsistencies between bridge and engine room records of movements on the night of 14 January, and it is not possible to reconcile timings kept by the engine room of engine movements, with times of events kept by the bridge between 2225 and 2335.

During the investigation into this incident, the bridge and engine room clocks were compared and it was found that there was a difference of about a minute between the clocks, with the engine room clock one minute slow on the bridge clock.

The Police Station logged the time of the initial call to their station by the recreational fisherman who witnessed the incident as 2235. All other times given by witnesses are approximate only.

The Bureau of Meteorology's observing station at Broome Airport provided anemometer charts and a video of the weather radar picture from 2030 to about 2300. These give an accurate picture of the weather, although the local marine community report that conditions between the airport and the jetty, 6 km away, can vary significantly, particularly in relation to wind speed.

The Australian Tidal Facility has a tidal gauge at Broome Jetty. This facility records tidal height, barometric pressure, wind speed and direction. These records were provided to the Inspector.

The Weather

January weather in Broome is characterised by hot days, very warm nights and high humidity. It is the period leading to the "wet" season in that part of

Australia, characterised by frequent thunderstorm activity.

The domestic weather forecast issued by the Bureau of Meteorology for Broome on the evening of 14 January and the day of 15 January, was for west to north-west winds with risk of afternoon or evening thunderstorms, a minimum temperature of 19°C and a maximum temperature of 34°C.

Carabao 1 recorded the wind throughout the day of 14 January as westerly force 4 (11-16 knots) with a maximum daily temperature of 36°C, dropping to 30°C by 2000.

The weather radar at Broome records the radar display every ten minutes. At 1920 on 14 January (141120z), the leading edge of an isolated accumulation of cloud, apparently a storm-cell, could be seen on the radar 250 km east of Broome tracking in a westerly direction. By 2010 the leading edge of the cloud was at 200 km tracking directly for Broome. The radar indicated that the moisture level within the cloud would cause between 10 and 20 mm/hr of rain, however, the radar is unable to calculate the speed of winds associated with such systems.

Analysis of the radar shows that the system moved at an average speed of 80 km/hr. At 2110 (141310z) the cloud bank was 125 miles from the radar and at 2150, 50 km due east of the town. At 2230, the radar shows the town, port area and Bay enveloped in cloud. By 2400 on 14 January, the cloud was about 100 km west of the coast and dissipating.

The anemometer trace shows that from 0900 on 14 July, until about 1800, the wind was westerly averaging about 10 knots. Over the next few hours the wind speed dropped and at 2200 was two to three knots from the west-south-west.

Between 2224 and 2228 the wind speed increased from 3 knots to 40 knots, and the wind direction shifted from west-south-west to east-north-east. At 2232 a maximum gust of 42 knots was recorded at the weather station. By 2236 the wind had decreased to 30 knots. For the next ten minutes the wind strength varied between 20 and 31 knots, before dying away to 2-5 knots from a general westerly direction.*

The wind gust, as reported by a Police patrol, hit the town at 2225. The witnesses on the jetty were not sure of the time the storm hit the port area. They did describe having to hold onto a light pole to prevent being blown over and it was some minutes before they were able to telephone the Police to warn of the drifting ship.

Records received from the Australian Tidal Facility of Flinders University indicate that at 2200 the wind was from the west-south-west at about 7 knots with occasional gusts to about ten to 12 knots. The barometric pressure was 1009.6 and rising steadily.

Between 2200 and 2300 the maximum wind speed recorded was 54 knots (28 m/s) from the east with a maximum barometric pressure of 1011.1 hPa. There is no record of time of this maximum gust, but

* The Meteorological station has two anemometers. The second, high speed, anemometer is about one minute fast of the standard instrument and showed dead calm from about 1830 and a maximum wind speed of 46 knots at about 2230.

it is reasonable to assume that this was the squall reported at about 2225. The wind speed, about 15 knots higher than that recorded at the Meteorological Station at the air port, is consistent with a wind speed of Beaufort Force 11 (56-63 knots) estimated by the Master.

The Australian Tidal Facility data also shows that at 2300 the wind was east of north and the speed had fallen to 15 knots and continued to decrease into the morning of 15 January with the wind reverting to a westerly direction by 0200.

At 0412 on 16 January, a similar sudden squall hit Broome Harbour with winds of 40 knots from the south-east causing *Carabao 1* to start to drag anchor once again. The build up to the squall was more gradual, however winds of over 30 knots lasted for about 30 minutes. On this occasion, the engine was used to reduce the weight on the cable and, after the squall passed, the anchor was weighed and the ship was repositioned.

Storms in the Broome area

The Pilot, the Police and others interviewed stated that isolated thunderstorms are a frequent occurrence in January, however, the storm experienced by *Carabao 1* on 14 January was unusual in its intensity and ferocity.

The Coastal Waters Weather Forecast for the 14 January predicted west to north-west winds of 8 to 18 knots. The "Provincial Towns" forecast for Broome predicted the risk of an afternoon/evening thunderstorm, and west to north-westerly winds. This forecast is not unusual for the time of year. The observing weather station at Broome is unmanned from about 2000 and the approaching cloud from the east would not have been noticed on the radar.

The Australia Pilot, Volume V[1], warns:

"The approaching hot season of the NW Monsoon is preceded by sharp, short-lived squalls of increasing frequency and intensity. Squalls can produce winds of gale force and are often accompanied by thunderstorms. As they pass over there may be a sharp drop in temperature and a rise in pressure, whilst a sudden strong gust of wind may occur."

However, Australia Pilot, Volume V does not give any further detail and information from the Broome climatic table would suggest that easterly winds in the afternoon occur only on 6 per cent of occasions and they are light at about 3 knots.

The Bureau of Meteorology provided statistics on the frequency of thunderstorms moving from east to west during the three month period December to February over ten years from 1987 to 1997. Over this ten year period an estimated 143 such storms moved across Broome. Thirty seven of these storms generated winds in excess of 30 knots and 10 storms, or 7 per cent of the total number, generated winds in excess of 40 knots.

The Master received the coastal weather forecast, but the ship did not listen to land based weather forecasts. The formation of storms and accompanying squalls may be common to north and north-west Australia at this season, however there

[1] Australia Pilot, Volume V, North and North-West and West Coasts of Australia from the West Entrance of Endeavour Strait to Cape Leeuwin, Seventh Edition, 1992

was little to warn the Master of the frequency or potential severity of such squalls. No information of the possibility of such storms was provided to him by the Port Authority.

Ship watchkeeping

Following the incident on 14 January, allegations were made by witnesses ashore that *Carabao 1* was not maintaining a proper anchor watch.

The evidence is that a qualified navigator was on the bridge throughout the ship's time at anchor. The engine room was not left unattended, though at night an engine room rating, rather than a qualified engineer, maintained a watch with an engineer officer on call and making periodic visits to the engine room.

The Master's "Bridge Order Book" contained the entry for each day at the anchorage instructing the officer of the watch that if any dragging of the anchor was detected, the duty engineer was to be called to start the engine and the Master and Boatswain were also to be called.

There was some ambiguity in the understanding of engine readiness. The Master and Chief Engineer stated that the engine was on immediate notice for starting. The turning gear was not engaged and the lubricating oil and ancillary equipment were kept running. The starting air in the air bottles was maintained between 24 bar and 30 bar. However, it seems that the term "immediate" was accepted as being about 10 minutes under normal conditions, although with the small engine size it should have been a case of just the initial movement of the fuel lever to start it. However, because there was no engineer officer in the engine room when the squall struck, the engine was not started until the Chief Engineer arrived at the engine control position. The evidence is that the engine was ready within five minutes, probably about three minutes, from the time the engine room was first alerted.

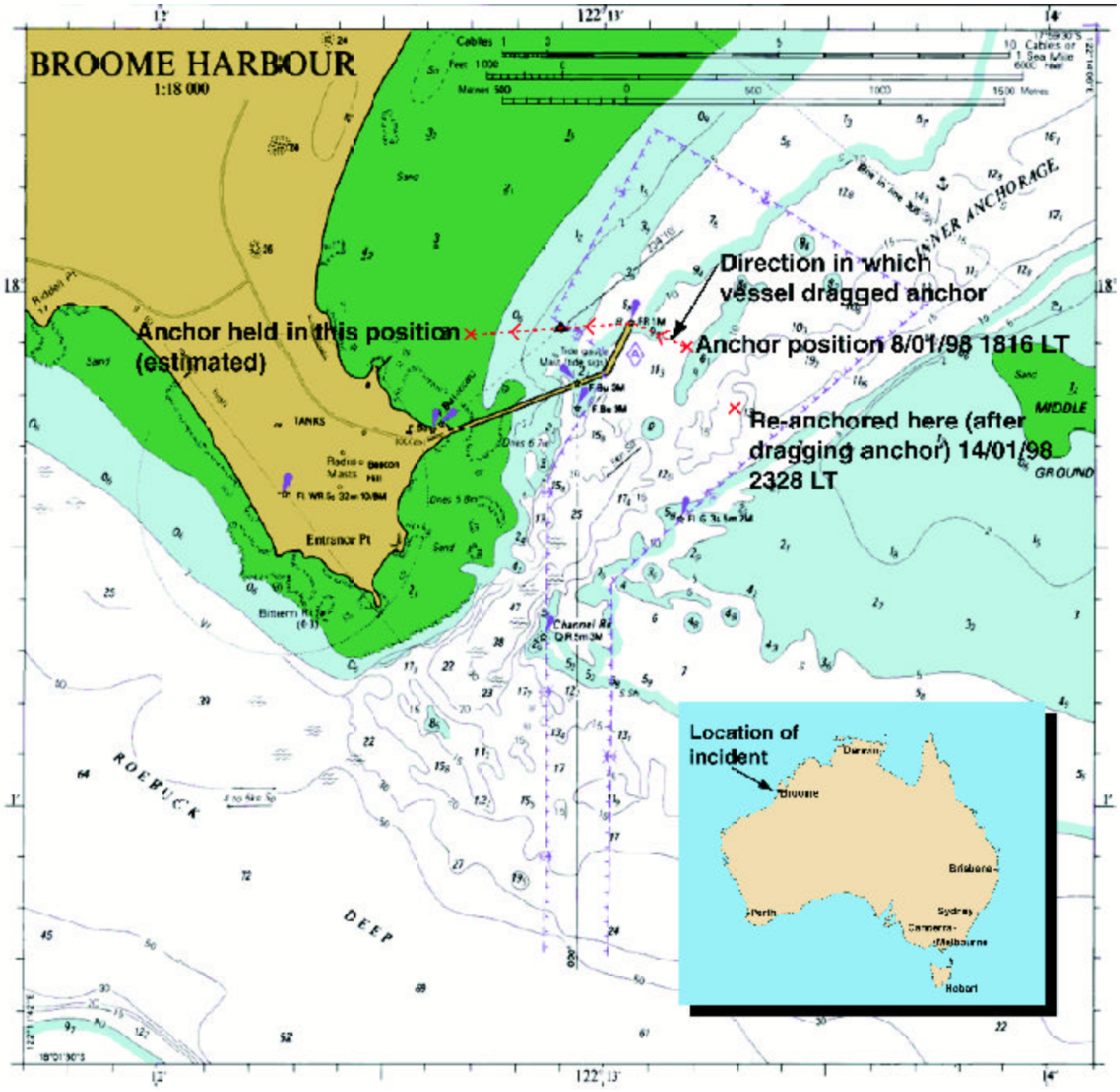
There is no substantive evidence to suggest that the proper watches were not being maintained on board *Carabao 1*. Although it is possible that the engine could have been available three minutes earlier at about 2227, given the force of wind experienced within seconds of arrival of the squall and the proximity of the ship to the wharf, contact with the wharf would not have been prevented. Whether the further drift of the vessel after 2228 could have been prevented is open to conjecture.

The incident

There is no doubt that the squall struck without any warning shortly after 2225. There was nothing that the ship could have done to predict the arrival of the squall or the wind speed, which reached 54 knots within a few minutes.

By the time it was realised that the anchor was not holding, the vessel may have been less than 70 m or a ship's length, from the jetty. There was very little time for the Master and crew to react and the vessel struck the jetty before the engine was available.

As well as informing the engine room that he required to use the engine immediately, the Master's other reaction was to pay out more anchor cable, in the hope that this would allow the anchor to dig in and hold the ship.



Portion of chart Aus 50 showing anchor positions of Carabao 1

It is not clear how long it took for the Mate and Boatswain to reach the forecastle head. The Mate's evidence was that the vessel was virtually alongside the jetty when he arrived on the forecastle, and witnesses ashore reported that when they first realised the ship was moving, they did not see anyone on the forecastle.

When the Mate and Boatswain reached the forecastle, instead of paying out more cable by releasing the brake, the Mate intended putting the windlass into gear to "walk back" cable from the ship. If they had succeeded in walking back cable with the windlass in gear, it is doubtful if the windlass could have paid out sufficient cable to halt the vessel's drift. The Master stated that it was the practice aboard *Carabao 1* under adverse conditions, to pay out cable with the windlass in gear, because this was safer than controlling cable with the brake.

In any event before any more cable could be paid out, the vessel hit the jetty. In the opinion of the Inspector, it is probable that the vessel was too close to the jetty to pay out enough additional cable and halt the ship's drift, either by walking back cable with the windlass in gear, or by releasing the brake. Given the speed with which the ship was drifting, there was little that could have been done to avert the immediate consequences of the anchor dragging as, by the time the engine was ready, the ship had struck the jetty and drifted further west. The Master considered letting go the starboard anchor but, in his opinion, the vessel was too close to the jetty to permit this anchor to be used.

The engine was ready shortly after the ship made contact with the jetty but the Master delayed using the engine until he was sure the vessel was afloat and the propeller was clear. During this time *Carabao 1* came into contact with four small vessels moored between the jetty and the shore. Events occurred so rapidly, it is doubtful if use of the engine as soon as it was ready would have established control of the vessel and stopped it drifting, in time to prevent contact with the small craft.

The ship was extremely lucky that after dragging anchor so swiftly in such a confined area, the anchor held again and prevented the vessel from grounding. This gave the Master the opportunity to establish that it was safe to use the engine and manoeuvre, away from the lee shore, back to the anchorage.

The inconsistency in times between the bridge and engine records and the lack of any other supporting evidence makes an accurate reconstruction of events difficult. The propeller pitch movements after 2301 (two at dead slow ahead for just under a total of six minutes, and the dead slow astern pitch logged at 2313:15) would suggest that the ship was in its new anchorage position at about 2313, rather than 2328 as recorded by the bridge. The bridge records, as previously stated, cannot be relied upon. The Inspector sees nothing sinister in this, and it probably reflects the stress of the moment.

It seems from eyewitness accounts, that between 2228 and 2234, *Carabao 1* had dragged anchor over a distance of 600 m or more before the anchor held and arrested the drift.

The anchorage

The area off the berth is designated a prohibited anchorage and is not used if other vessels are expected to berth at the jetty. As no other vessels were expected

during Carabao 1's stay, the vessel was anchored off the wharf. The seabed is sand and is considered to provide good holding ground. Tankers over 180 m in length and cruise liners with significant windage have anchored safely in strong winds in the anchorage to the east of Broome Jetty.

Carabao 1 is equipped with port and starboard anchors, each of 1.59 tonnes, attached to 34 mm diameter chain. The starboard anchor is attached to 8 shackles of cable (220 m) and the port anchor to 7 shackles (192 m).

The vessel anchored in a charted depth of about 10 m, using about 100 m of chain measured from the anchor to the hawse pipe, allowing a vertical distance of about 3 m between the hawse pipe and the water. The predicted range of tide of about 8.0 m on 14 January meant that *Carabao 1* would have been in a maximum depth of 18 m of water and a minimum of 10 m. Based on the formula for the minimum cable required, $25\sqrt{D}$ (where D is the depth of water in metres), *Carabao 1* required 106 m. The scope[2] of chain deployed varied between 5 and 7.7. The scope of *Carabo 1's* cable was very close to that recommended in theory.

Carabao 1 is about 70 m in length. When the ship anchored on 8 January 1998, the anchor was dropped approximately 240 m east of the end of the jetty, and 3 shackles of cable were paid out in the water. The Master subsequently paid out an estimated further half shackle making a total length of chain of 3½ shackles or 96 m of chain in the water. With the chain stretched out the radius of the circle centred on the anchor and described by the ship's stern was about 170 m, which, given the right circumstances, meant that the stern could swing as close as 70 m from the jetty.

A number of witnesses stated that *Carabao 1* was lying in a north-easterly direction. When the squall struck, the anchor cable would have become bar tight and would, in all probability, have lifted the anchor shank causing the anchor to break out of its ground. It seems that the vessel then sheered in a clockwise direction till the wind was on the port beam, and dragged anchor till it struck the jetty and four small craft before coming to a stop.

The dragging of *Carabao 1's* anchor is the fourth similar incident investigated by the Unit since November 1995.[3]

The investigations into these incidents highlight the International Association of Classification Societies design standards for anchors. The anchoring equipment is intended for temporary mooring within a harbour or sheltered area when the vessel is awaiting a berth or the tide.

A1.1.2 The equipment is therefore not designed to hold a ship off a fully exposed coast in rough weather or to stop a ship which is moving or drifting. In this condition loads on the anchoring equipment increase to such a degree that its components may be damaged or lost owing to the high energy forces generated, particularly in larger ships.

Anchoring equipment is designed to hold a ship in good holding ground. The size of the equipment is based on the ship's displacement at summer load water line,

[2] The length of cable laid out measured from the hawse pipe to the anchor divided by the vertical distance between the hawse pipe and the sea bed.

[3] See Incident reports No.86, No. 91 and No. 103

the ship's breadth and the area of hull above the summer load water line exposed to wind.

A1.1.4 The Equipment Number formula for anchoring equipment here under is based on assumed current speed of 2.5 m/sec, wind speed of 25 m/sec[4] and a scope of cable between 6 and 10, the scope being the ratio between the length of chain paid out and water depth.

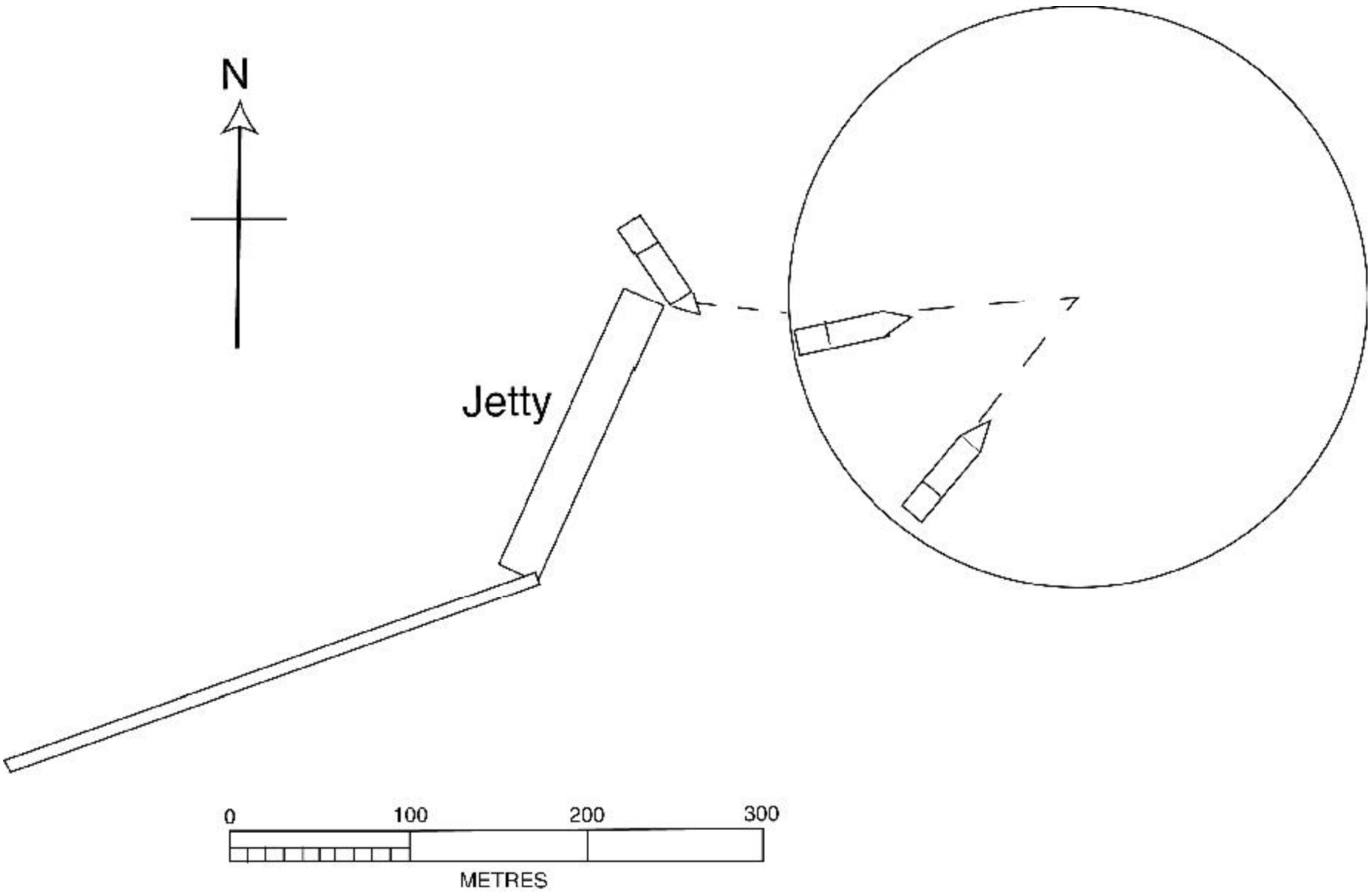
Anchors provide maximum holding power when the cable is pulling horizontally at the anchor shank. The efficiency of the anchor is reduced significantly as the angle between the horizontal and the cable at the anchor shank increases. A rule of thumb is that a pull 5° above the axis of the anchor reduces the holding power by 25 per cent and a pull of 15° above the axis of the anchor reduces the holding power by 50 per cent[5].

In the particular circumstances the proximity of *Carabao 1* to the jetty was an important factor. The Pilot considered the anchorage to be safe, and the Master did not question the Pilot's judgement. Although anchored in proven holding ground, in the event of the anchor dragging in an easterly wind there was little time to react.

However, the prevailing and forecast wind was from the west and if the ship had dragged to the prevailing wind there was 500 m clear water between the anchor and shoal water to the east, giving a reasonable margin of safety.

[4] 4.86 knots current, 49 knots wind speed

[5] Danton, G., The Theory and Practice of Seamanship, 10th Edition Revised. (1987), Routledge, London



Broome jetty and anchorage

Conclusions

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

The following factors are considered to have contributed to *Carabao 1* dragging anchor:

1. The proximity of the ship's anchor position to the jetty in the event that *Carabao 1* was driven toward the west.

2. There was no information available to the Master to warn him of the possibility of squalls developing and causing strong easterly winds.

3. The delay, however minimal, of starting the ship's engine

It is also considered that:

4. The likelihood of occurrence of such squalls should have been known to the local harbour authority and the pilot.

5. Even if, with the engine available, contact with the jetty could not be prevented, there was the possibility that dragging of the anchor further west through moored small craft, could have been avoided.

Submissions

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

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

The Pilot

The Master

The Chief Engineer

An acknowledgement was received from:

The Pilot

The Pilot agreed that the report was clear and accurate. He also agreed with the conclusions mentioned in the report.

Details of Carabao 1

Previous name	City of Dubai (1994)
IMO No.	7368736
Flag	Singapore
Classification Society	Germanischer Lloyd
Ship type	Livestock Carrier
Owner	Labroy Marine (Pte) Ltd. Singapore
Charterer	Rooney Shipping & Trading Pty Ltd, Berrimah, NT.
Year of build	1974
Builder	Haugesunds Slip A/S, Norway
Gross tonnage	1487
Net tonnage	634
Summer deadweight	1941.3
Length overall	69.73 m
Breadth extreme	13.21 m
Draught (summer)	5.312 m
Engine	B&W Alpha 4SA 16 cylinder diesel
Engine power	1825 kW
Crew	15 Filipino