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Australian Transport Safety Bureau

AUSTRALIAN TRANSPORT SAFETY BUREAU

MARINE SAFETY INVESTIGATION
REPORT 162

Independent investigation into the grounding
of the Malaysian flag container ship

Bunga Teratai Satu

Sudbury Reef, Great Barrier Reef
2 November 2000

COMMONWEALTH DEPARTMENT OF TRANSPORT AND REGIONAL SERVICES

Report No 162

Navigation (Marine Casualty) Regulations investigation into the grounding of the Malaysian flag container ship *Bunga Teratai Satu* on Sudbury Reef, Great Barrier Reef on 2 November 2000

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CONTENTS

Figures

Figure 1:
***Bunga Teratai Satu* aground on Sudbury Reef**

Summary

The Malaysian flag container ship *Bunga Teratai Satu* sailed from Singapore on 26 October 2000, bound for Sydney via the inner route of the Great Barrier Reef with a cargo of 857 containers. A licensed pilot was embarked to conduct the navigation through the inner route between Goods Island and Cairns.

At 0554 AEST on 2 November 2000, *Bunga Teratai Satu* disembarked the pilot at Yorkeys Knob, off Cairns, at the southern limit of the compulsory pilotage area.

At 0600, 'full away' was rung and the vessel resumed its passage to Sydney on a course of 120° (true). A programmed way-point, at position 16° 52.8' S, 146° 02.3' E, was reached at 0700. At this way-point, the course was supposed to be altered to 164° (true) to round Fitzroy Island and take the vessel to the west of Sudbury Reef. However, no course alteration was made.

The ship was reporting under the Great Barrier Reef Ship Reporting System, REEFREP, administered from Reefcentre, Hay Point. This system requires ships transiting the inner route to report at certain positions within the inner route. To help enforce compliance with pilotage and reporting requirements the normal entry points to the inner route are monitored by radar. In the limited areas covered by radar, the system fulfils a secondary, monitoring role, to improve safe navigation.

Bunga Teratai Satu had been acquired as a target at Reefcentre when it entered the area covered by the Green Island radar system at about 0430. From about 0715 to 0725, the Reefcentre operator was attempting to re-establish lost targets on the Hammond Island radar display covering the western area of Torres Strait. Just before 0716 *Bunga Teratai Satu* entered the restricted zone (2 miles off Sudbury Reef) but the Reefcentre operator did not notice the alarm message as he worked on other tasks.

At about 0723, the ship struck the north end of Sudbury Reef at a speed of over 20 knots on a heading of 120°. It was about 1¾ hours after low water and the vessel's bow rode some 100 metres onto the reef leaving the stern in approximately 12 metres of water.

Nobody was hurt as a result of the grounding and no oil or other pollutant escaped from the ship. The grounding resulted in mechanical damage to the reef and the yet-to-be assessed effects of the ship's anti-fouling paint.

The Australian authorities issued detention orders while the ship's situation was being assessed. *Bunga Teratai Satu* remained fast on the reef until it was eventually refloated with the aid of tugs at about 0930 on 14 November 2000.

The investigation found that the significant unsafe act that resulted in the grounding was the inattention of the mate on watch aboard *Bunga Teratai Satu*, who was distracted by his wife's telephone call to their family overseas.

However, a number of other contributing factors led to a breakdown in the defences and protections that may have prevented the ship from grounding.

Sources of Information

Master and crew of *Bunga Teratai Satu*

Malaysian International Shipping Corporation

The Great Barrier Reef Marine Park Authority

Queensland Department of Transport

Telstra Corporation

Australian Maritime Safety Authority

Hydrographic Sciences Australia P/L

Hydrographic Office, Royal Australian Navy

Reference

Holden, D., Ross, K., Mansell, J., (2000) The Great Barrier Reef Review of Safety Initiatives.

Acknowledgments

The Inspector gratefully acknowledges the logistical support provided to the investigation by the Regional Harbour Master, Cairns.

Photographs of *Bunga Teratai Satu* supplied by The Courier-Mail newspaper, Cairns.

Narrative

Bunga Teratai Satu

Bunga Teratai Satu (fig. 1) is a Malaysian flag container vessel owned and operated by the Malaysian International Shipping Corporation Berhad (MISC), of Kuala Lumpur. The ship operates a regular service from Port Klang and Singapore to the Australian ports of Sydney, Burnie and Fremantle on an approximate 28 day cycle.

The vessel was built in Okpo, Korea, by Daewoo Heavy Industries Ltd and launched in 1998. Since building it had been maintained in class with Lloyd's Register as ✠100 A1 containership with ✠LMC, UMS (unmanned machinery spaces) notations.

Bunga Teratai Satu is 184.07 m in length overall (174.02 m between perpendiculars), has a moulded depth of 15.84 m and a maximum beam of 27.44 m. It has a summer deadweight of 21 642 tonnes at a summer draught of 10.218 m. All accommodation and machinery spaces are aft of the forward engine room bulkhead at frame 44. Forward of the engine room are five cellular cargo holds extending for 127 m to the collision bulkhead at frame 90. The holds are fitted with fixed cell guides and the vessel is able to carry a maximum of 1725 TEU (twenty foot equivalent units), including 242 refrigerated containers. The distance between the collision bulkhead and the forward perpendicular is 11.2 m; the bulbous bow extends 5.6 m forward of the forward perpendicular.

Bunga Teratai Satu is powered by a 6 cylinder, two-stroke, Burmeister & Wain type MC diesel engine of 600 mm bore and 2 292 mm stroke. The engine develops 12 260 kW and drives a single shaft with a fixed-pitch propeller, giving the ship an average service speed of 19 knots. When either manoeuvring or on passage, the engine is fuelled by heavy fuel oil, although it may be run on diesel fuel if necessary.

Fuel is carried in tanks towards the after part of the ship. Heavy fuel oil is carried in no. 4 side tanks between frames 65 and 54 (88 m and 112.5 m from forward respectively). Heavy fuel is also carried in no. 5 double bottom heavy fuel tanks between frames 54 and 44 (the engine room bulkhead, 145 m from the bow). The other side tanks (1,2,3 and 5), the forward deep tank, fore-peak and double bottoms (1,2,3 and 4) are dedicated water ballast tanks.

The ship is equipped with the normal range of navigation equipment including a JRC GPS receiver, type JLR-6800, and two radars, both JRC type JMA-9000, the starboard radar being fitted with ARPA. The bridge and chart room are combined. At the starboard after corner of the wheelhouse is the GMDSS equipment in a partitioned and curtained area.

At the time of the incident, all ship's certificates required under international shipping conventions were valid. In addition, the ship was enrolled in Lloyd's Register's 24-hour Ship Emergency Response Service, which provided 24-hour technical support in the event of an emergency.

The ship's complement consisted of the master, chief engineer, mate and 2nd engineer, who were Pakistani nationals and 27 other officers and ratings, most of whom were from Malaysia. The exceptions were the 2nd and 3rd mates who were from Indonesia, the 4th engineer who was from Bangladesh and the electrician who was from Myanmar. The master, who was thirty years of age, had held command for 18 months.

The mate, who was 46 years of age at the time of the incident, had a career at sea which spanned 27 years.

Bunga Teratai Satu, as a containership, is not required to hold an International Safety Management Certificate until July 2002. However, the policy of the owners was to operate the ship in accordance with the ISM Code and to have appropriate documentation in place on board.

The inner route of the Great Barrier Reef

The southern extremity of the Great Barrier Reef compulsory pilotage area is designated as 16° 40' S. The inner route, between Goods Island in the Torres Strait and this southern limit, is about 480 nautical miles in length[1]. The area contains stretches of relatively narrow fairway with restricted depths. The inner route is subject to intense seasonal fishing activity. The route offers a safe passage, sheltered from the sea conditions experienced outside the reef. The disembarkation point for pilots, who have navigated vessels south from Torres Strait, is off Cairns, about 8 miles south of the southern extremity of the compulsory pilotage area.

Before 1 October 1991, pilotage was offered on a voluntary basis. Since that date, following recognition by the International Maritime Organization of the Great Barrier Reef as a 'Particularly Sensitive Area', the Australian Government introduced legislation through an amendment to the Great Barrier Reef Marine Park Act, 1975, making pilotage through the inner route (and also Hydrographers Passage) compulsory for ships over 70 m in length.

To further enhance safety in the Great Barrier Reef a ship reporting system (SRS) for ships over 50 m in length navigating within the Great Barrier Reef was adopted by the International Maritime Organization in 1996. This was given effect, as of 1 January 1997, by a mandatory system of ship reporting at predesignated positions between the Torres Strait and Cape Townsend. A ship transiting the inner route between Torres Strait and Cairns is required to make some ten reports to Reefcentre. The system of radio monitoring is enhanced by remote radar coverage of the major entrance channels to the inner route. Both radio and radar are monitored from Reefcentre, at Hay Point just south of Mackay.

A radar positioned on Green Island, 13 miles to the north east of Cairns, provides coverage of the Cairns area. With a range of 30-35 nautical miles, its coverage includes Sudbury Reef, situated eighteen miles to the south east of Green Island.

Reefcentre

The scheme, REEFREP, is a joint Australian Maritime Safety Authority/Queensland Transport initiative, operated by Queensland Transport from Reefcentre at Hay Point near Mackay.

> The purpose of REEFREP is to enhance navigation safety in the Torres Strait and the inner route of the Great Barrier Reef, thereby minimising the risk of a marine accident and consequential pollution and damage to the marine environment.[2]

REEFREP is based on ships reporting by VHF to Reefcentre at designated points in the approaches to the reef and within the inner route, detailing position and speed and other relevant information. The information

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1 All references to miles refer to nautical miles (1852 m)

2 Ausrep and REEFREP (1998) Australian Maritime Safety Authority & Queensland Department of Transport (Maritime Division)

is entered into a Traffic Information Module (TIM). TIM calculates the ship's 'dead reckoning' (DR)[3] position based on the predesignated routes and advised speed. The ship's information is updated at every reporting point (at intervals of about 8 hours, dependent on speed). If a ship alters speed or deviates from its planned route to any significant degree it is required to report to REEFREP, where the operator amends the information in TIM. TIM automatically correlates the information with all other ships in the system and predicts the time that ships will encounter each other. This information is relayed to the ships in the scheme.

The VHF information is supplemented by a radar system module (RSM). Radar coverage is from two sites in Torres Strait (Warraber Island and Hammond Island), Green Island (about 15 miles east-north-east of Cairns) and Penrith Island. Each site covers a radius of about 30 miles, hence the radar coverage is limited in terms of the whole extent of the inner route.

Radar surveillance is sited to cover the main entry points of mandatory ship-reporting and also covers the compulsory pilotage area entry points within the Great Barrier Reef, the inner route and Hydrographers Passage to:

> …assist in the detection of ships entering the system and in monitoring their movement within the system while in the coverage of the radars. The radar detection of ships entering the system will also serve to monitor compliance with the (mandatory) requirement for designated ships to make the appropriate VHF reports.[4]

The high probability that a ship failing to report, as required by Australian law, will be detected by the radar system is an effective deterrent to any master failing to report under the SRS or seeking to avoid embarking a pilot.

There are two displays on the TIM system. One screen, the data entry component, records in text boxes information on individual ships within the system. It is this screen into which the initial ship report is entered and updates are made. The system also generates 17 different alert conditions, which are displayed in a text box. Fourteen alert messages are routine and three are urgent (ships entering a restricted area, a pilotage area, or crossing a boundary line).

The other screen, Sirius, shows an electronic chart of the inner route, which generates a DR position of all ships in the system. The operator can 'zoom' to any part of the inner route to obtain a more detailed picture of any given area. In the event of an 'urgent operator alert' a text box is generated on the Sirius screen in addition to the text message on the data entry screen.

AMSA is responsible for the operation of the radars at Hammond Island, Warraber Reef and Penrith Island. Queensland Transport is responsible for Green Island radar.

The radar system supplements TIM. The radar targets of reporting ships are identified on the real time radar scan. The radar and TIM targets are 'fused'[5] and the ship's position in TIM is then maintained by the radar system, while the ship is under radar

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3 Dead Reckoning Position, a position obtained by applying course and distance made through the water from the last known observed position.

4 Ship Reporting System project document.

5 Fusing is the reconciling of the dead reckoning position (DR) with the real time radar position.

coverage. The highest risk area, and the area of most activity, is Torres Strait.

Arbitrary restricted areas enclose the limits of the fairways, shallow waters or reefs within the radar coverage area. Off Sudbury Reef the restricted zone was set two miles from the reef. A ship entering a restricted area initiates an alert on the Sirius screen in the form of a window message:

> There is a new alert message

Acceptance of this message triggers an 'urgent alert' in the alert box on the data entry screen:

> Ship (ship's name) has entered restricted area (location)

The operator sits at a display of four radar displays on top of an operational screen, the two TIM displays and a VHF communications unit.

Reefcentre also operates as the Vessel Traffic System for Hay Point, Dalrymple Bay, Weipa and other small ports on the Cape Peninsular. Two VTS operators work a 12 hour shift from 1900-0700 or 0700-1900. One operator is dedicated to the REEFREP system for about six hours and one to the Port VTS. The duties are then interchanged.

The incident

Bunga Teratai Satu sailed from Singapore on 26 October, on voyage 407 on its regular service to Australia, via the inner route of the Great Barrier Reef, with Sydney designated as the first port of call. The ship was carrying 857 containers, 551/20 foot and 306/40 foot containers. Twelve containers were listed as carrying some dangerous goods amounting to some 126 tonnes.

At 0300[6] on the morning of 1 November the ship embarked a pilot, together with a trainee pilot, at Goods Island at the western approach to the Prince of Wales Passage in Torres Strait. The ship's draught for the passage was 8.3 m forward and 8.49 m aft. The pilotage through the inner route of the Great Barrier Reef proceeded without incident. On suitable occasions, the pilot took rest periods leaving the officer of the watch in charge of the navigation. The passage through the inner route was anticipated to take between 26 and 27 hours.

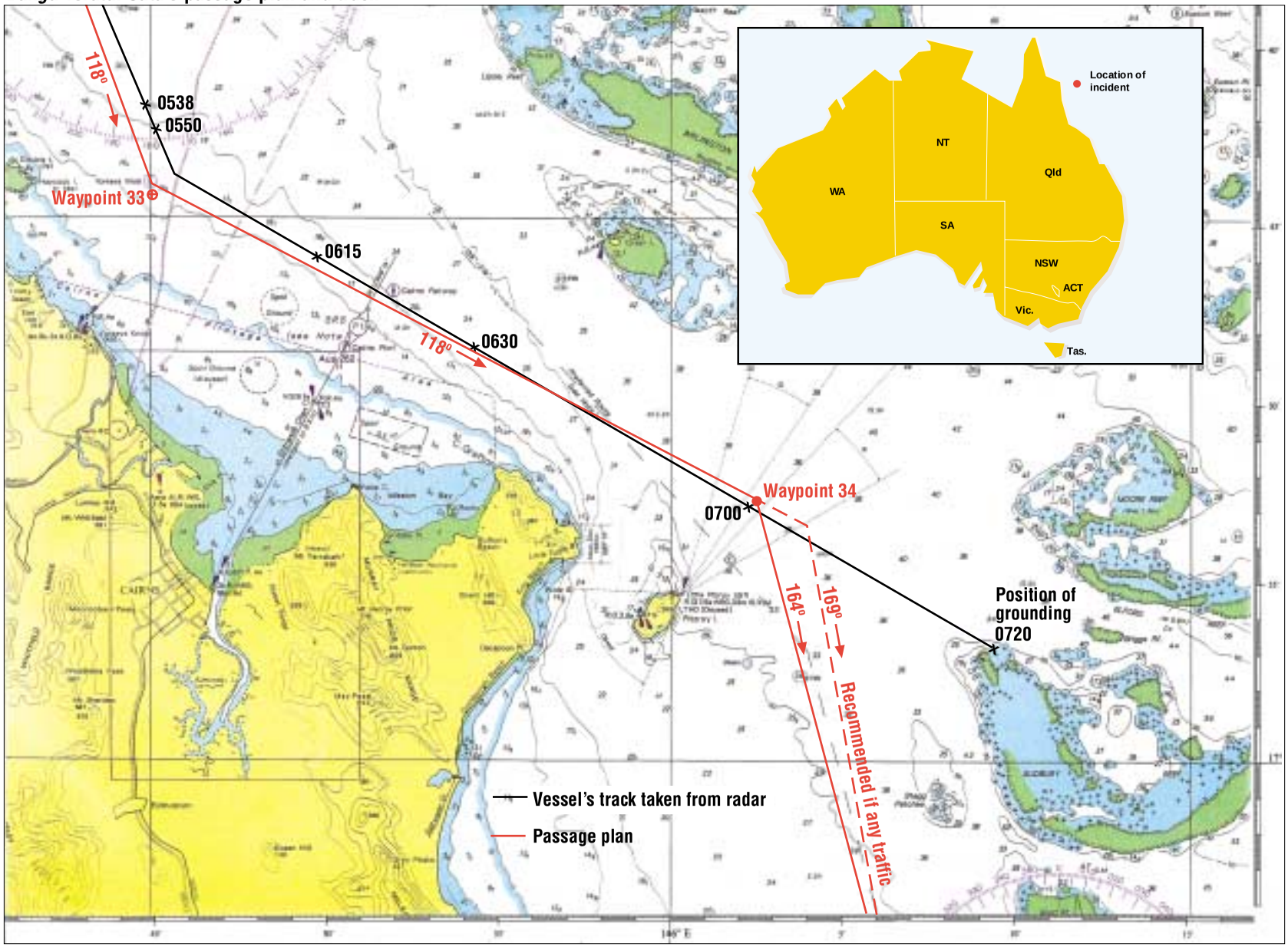
At 0400 on the morning of 2 November the mate took over the watch from the 2nd mate and the able seaman (AB), on lookout and helm duties, changed. The ship was about ten miles north of Low Isles, near the southern extremity of the compulsory pilotage area. The ship passed Low Isles at 0427. At 0430, about 22 miles north of the pilot ground, the mate gave the engine room one hour's notice of readiness to manoeuvre. The ship's position was plotted at about 15-minute intervals.

At approximately 0500 the master made his way to the bridge. The pilot, who had been resting, arrived on the bridge at 0530 and the AB was instructed to change to hand steering. The pilots disembarked at 0550 at the pilot boarding ground off Yorkeys Knob, north of Cairns (waypoint 33 in the ship's passage plan see fig. 2). To make a suitable lee for the disembarkation the ship turned to a heading of 270° (T). Once the pilot boat was clear the master continued to turn to starboard to bring the ship to a course of 118°(T).

Once the pilots were disembarked the master instructed the mate to ensure that the pilot ladder was properly stowed and to go

[6] All times are Australian Eastern Standard Time

Figure 2:
***Bunga Teratai Satu's* passage plan and track**



to the forecastle head and secure the anchors for the open sea passage. The master then called Reefcentre on VHF and reported that the pilots had disembarked and the ship was proceeding south to Sydney. The response from Reefcentre included information that there was no other traffic in his vicinity and a request to keep reporting to Reefcentre as normal. At 0600 the engine room was advised to start working up to full sea speed.

At 0615, shortly before the mate returned to the bridge, the master plotted the ship's position on the chart. At about 0620, the steering was set on 'autopilot' with a course of 120°(T). When the mate had returned to the bridge, the master and mate discussed the high consumption of fresh water and the need to curtail water consumption for a few days. Navigation through the remainder of the inner route and the continuing requirement to report to Reefcentre was also discussed. The master asked the mate to get out the folder containing the instructions and reporting positions for the passage through the Reef. The master subsequently plotted the 0630 position on the chart by radar range and bearing. At about 0635 the master, satisfied that the mate had familiarised himself with the vessel's situation and navigation, gave the mate the conduct of the vessel and left the bridge. He made his way down to his cabin, where he attempted to find a weather forecast on the television to monitor a low pressure system off the coast of New South Wales.

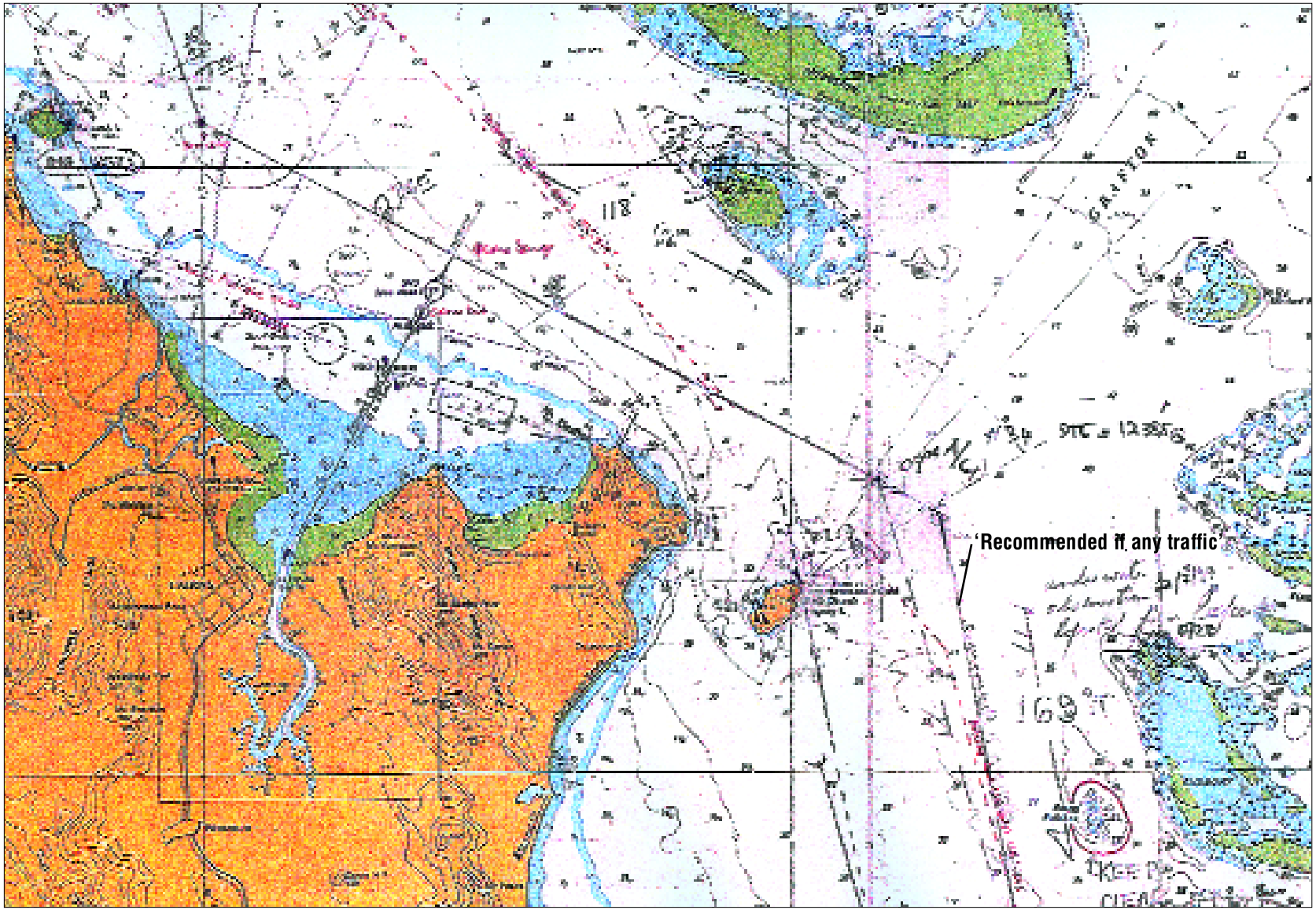
Sunrise had been at 0537. The sky was partly cloudy, the wind from the north-north-west at about 5 knots and the air temperature was about 25°C.

At about 0640, the duty AB started cleaning the bridge. The sun was low in the east about 20 degrees on the port bow. He lowered the tinted sun-screens to reduce the direct glare of the sun. The mate went out onto the starboard bridge wing and made a call on his mobile telephone. Soon afterwards, at about 0655, the mate returned to the wheelhouse and called his cabin on the internal telephone, asking his wife to come to the bridge. She arrived a few minutes later and the two of them went out onto the starboard bridge wing before making another call on the mate's mobile telephone to his mother-in-law's house in Karachi.

The mate had developed a practice, of asking the AB to plot the ship's position from the GPS every hour when the ship was in open waters. The AB finished cleaning the bridge and, at about 0700, he plotted a position of 16° 53.0' S, 146° 02.4' E on the chart and entered it in the GPS Position Record book. (Fig. 3) The position plotted was adjacent to waypoint 34 on the ship's passage plan, where the ship's course was due to be altered to 164° off Fitzroy Island. The AB moved to the forward part of the bridge on the centre line. According to the AB, he kept expecting the mate to come back into the wheelhouse to alter course. But the mate did not re-enter the wheelhouse until about 0715, whereupon he and his wife proceeded to make some coffee at the sink at the port side of the wheelhouse.

At around 0717, after making coffee, the mate went to the chart table and checked the 0700 position. He looked over the chart table console and told the AB that he had made a mistake in plotting the position. Shortly afterwards he told the AB 'change to hand steering'. He then asked the AB for the ship's heading to which the AB replied '120°', the mate said 'steer 180°'. The AB however, could see a sand cay on the ship's starboard bow and, instead of altering course, asked the mate if he was sure that he wanted to turn to 180°, towards the sand cay. He added words to the effect, 'Chief,

Figure 3:
Chart showing plotted passage plan from *Bunga Teratai Satu*



can we go over shallow water?' The mate then responded 'turn 180° to port'. Confused, the AB did nothing and, seconds later, they felt the ship shuddering as it took the ground.

At about 0720, the master had noticed on the gyro-repeater in his cabin that the ship was still on a course of 120°. Knowing that the course should have been altered to the south some time earlier, he left his cabin for the bridge. He was near the stairwell when he felt the ship shudder. He ran up the stairs and arrived on the bridge, where he saw the AB on the wheel, the mate in the centre of the bridge and the mate's wife by the sofa at the port side of the bridge. The mate said 'I am altering course to 180°'. The master could see that the vessel was on the reef and that the telegraph was still on full sea speed. He pulled the telegraph back to 'stop' and then sounded the general alarm and said to the mate 'chief, the vessel is aground'. The time was recorded in the bridge movement book as 0721 and on the automatic engine movement recorder, at 0723. Also at 0723, the main engine lubricating oil low level alarm sounded as the vessel listed to starboard.

The ship was aground on the northern end of Sudbury Reef, on a heading of 120° with a starboard list of about 7°. The position of the bridge was 16° 57.0' S, 146° 09.4' E. It was about 2 hours after low water with a predicted tidal height of about 1.1 m above datum.

The master checked the chart and saw that the last position had been plotted at 0700. The 2nd and 3rd mates arrived on the bridge, whereupon the master instructed them to conduct soundings of all tanks. At the same time, he started to look up information relating to the company's emergency procedures and then tried to call the company's Emergency Response Centre (ERC) in Kuala Lumpur, but was unable to get a reply.

At that time, *Bunga Teratai Satu* had on board 1211.8 tonnes of heavy fuel oil and 94 tonnes of diesel. The 12 20-foot containers of dangerous goods, amounting to about 126 tonnes, included classes of flammable liquids, toxic substances, corrosive material and other miscellaneous classified goods, amongst which were polystyrene beads, alcohol, perfume, food flavouring, and pesticides. All were stowed correctly with the required separation.

At about 0737, while the tanks were being sounded, the ship received a call from Reefcentre on VHF asking about their position, to which the master replied that they were aground. The master advised Reefcentre that nobody on board had been injured and there had been no pollution. Subsequently he tried to call MISC in Sydney but, as there was no answer, he left a message advising them of the situation. The emergency procedures advised that, in the event of not being able to contact the company's ERC, he should call any or all of the home telephone numbers of the company superintendents and managers. Accordingly, the master called and spoke to one of the superintendents.

During this time, a watch was being kept for any sign of pollution leaking from the vessel. As the tanks were being sounded, reports started to reach the bridge that there was no indication, so far, of any tanks having been breached. (Later it was determined that the forepeak tank had been breached.)

Soundings of the sea around the ship established that the ship was aground from the bow to about its mid length. The rudder and propeller were in about 12 m of water.

The Queensland and Commonwealth authorities maintained contact with *Bunga Teratai Satu* through Reefcentre. The master passed information on the bunker oil carried on board and other relevant information to the Australian authorities. Although no breach of the hull was reported, initial steps were taken to respond to any possible oil pollution. Detention orders were placed on the ship by both the Queensland and Commonwealth authorities.

Events at Reefcentre

On 2 November the day operator arrived at Reefcentre at about 0645 to takeover the watch. He was an experienced operator, who had been with Queensland Transport for some 14 years and at the Hay Point centre for 10 of those years.

He examined the hand-over book, in which no problems were recorded. He looked at the screen displays and scrolled down through the whole system looking for any comments on ships in the SRS. He was told by the outgoing operator that the *Bunga Teratai Satu* had just dropped off the pilot at Cairns and he noted its position on the Green Island radar screen as just north of Cape Grafton. Also the Royal Australian Navy's survey vessel *HMAS Melville* was engaged in survey operations in and around Gannet Passage, which he could see on the Hammond Island Radar display.

There were a number of ships being monitored by the TIM system and two others about to enter the system. As he took over the watch a few minutes before 0700 the vessel *Asian Queen* made its first report approaching Gannet Passage, en route to Booby Island to embark a pilot for the Great North East Channel.

The initial reporting formalities involved between three and four minutes of VHF transmission. A few minutes later a local vessel called on VHF reporting its movement in the southern part of the compulsory pilotage area.

The Sirius display was centred on the Hammond Island Radar. At about 0711 a second vessel, *Thor Princess*, entering Torres Strait by Gannet Passage, made its first report. This procedure also lasted about three minutes.

The operator then fused the real-time radar information of *Asian Queen* with the DR from TIM. He then repeated the procedure for *Thor Princess*. These two operations took about four minutes.

At about 0715 the real time radar echo of *Jin Hui*, on the eastern side of Torres Strait was lost, the display reverting to a DR target. The operator set about restoring *Jin Hui's* fused target. About four minutes later the echo of *Asian Queen* also reverted to DR, followed soon after by *Thor Princess's* display. The operator also restored these targets. This took until about 0727. There was also regular, continuing, routine VHF traffic until a lull at about 0732.

At about 0736 the operator noticed an 'urgent' alert message on the Sirius display which was still centred on the Hammond Island radar area. On checking the TIM information screen he saw a message:

> Ship *Bunga Teratai Satu* has entered restricted area STAGG PATCHES

The operator checked the Green Island radar display and selected the Green Island area on the Sirius display. The normal shipping tracks were shown on the radar. One echo was seen close to Fitzroy Island. The operator's first reaction was that this was *Bunga Teratai Satu*. But he quickly realised that the target was showing a north-bound

vector and it was probably a tourist craft or fishing vessel.

He then realised that an echo showing no vector on the north east corner of Sudbury Reef, was in fact *Bunga Teratai Satu*. At about 0738 he called the ship and asked for its position. The master, in reply confirmed that the vessel was aground in position 16° 57.04' S 146° 09.41' E.

At 0748, the operator reported the grounding to the Queensland Department of Transport and the Rescue Coordination Centre, Australia. A little later, the operator at Reefcentre called *Bunga Teratai Satu*, requesting information on the quantity of fuel on board and also details of any dangerous cargo carried. Additional requests from Reefcentre for information on how the vessel happened to go aground elicited no explanation.

Bunga Teratai Satu called back to Reefcentre advising the operator of the dangerous cargo carried - class 3.2, class 3.3, class 6.1, class 8 and class 9. The master detailed the types and quantity of fuel carried on board. In addition, the master stated that the ship was only aground forward, that there was no pollution and that there did not appear to be any breach of the hull. The ship also reported the weather conditions as clear with the wind force 3 from the north.

Two officers from the Queensland Department of Transport boarded the ship that morning to make an initial assessment of the situation.

Emergency response

The Queensland Department of Transport Emergency Plan was immediately initiated. The Regional Harbour Master based in Cairns took control as the designated Incident Controller. He was responsible for coordinating the refloating operation and contingency planning. While the authorities assessed the risk of oil pollution as low, the serious consequences of such pollution made the deployment of oil spill response equipment and support teams a priority. The National Plan[7] and the Queensland Coastal Contingency Action Plan were activated at 1046 on 2 November.

Throughout the operation the Harbour Master liaised with the salvors, a large number of interest groups and MISC management.

Refloating

A salvage master and salvage team from United Salvage boarded the ship on 4 November. The vessel's forward section, forward of frame 60, extended some 100 m onto the reef. Aft of frame 60 the ship was afloat, with the stern in approximately 12 m of water. Over the following days calculations were undertaken to assess the ship's 'ground reaction'[8], stability and to develop a refloating plan. Two independent programs, the ship's own stability computer and the salvor's own program were used to check the ship's stability.

Over the ensuing days, to prepare *Bunga Teratai Satu* for refloating, the ship's fuel was transferred within the ship. Ballast was also transferred and some ballast water,

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7 The National Plan to Combat Pollution at Sea

8 Ground reaction is the function of the pressure exerted by the ship on the ground, equal to the loss of buoyancy due to stranding.

previously taken on in Australian waters, was pumped to the sea with the permission of the Australian Quarantine and Inspection Service.

After laying ground tackle and using tugs and the ship's engine *Bunga Teratai Satu* was refloated at 0928 on 14 November. The ship was anchored off Fitzroy Island and the hull inspected by divers. Apart from the forepeak, the ship's hull remained intact although plates were indented and heavily scored.

Throughout the twelve days aground, no polluting substance escaped from the ship or the attendant craft. The mechanical damage to the reef and any longer term effect of the ship's tributyltin-based anti fouling paint is yet to be assessed.

Comment and analysis

Evidence

This report is based on the interviews of the master, the mate and the duty AB of *Bunga Teratai Satu*, the ship's GPS, charts, logs and other bridge documents. Information relating to the mate's telephone call to Karachi was obtained from Telstra.

The duty SRS operator at Hay Point was also interviewed and system records of the REEFREP data were provided through Hydrographic Sciences Australia. A recording of the Reefcentre's radar display showed the vessel's movements between Yorkeys Knob and Sudbury Reef, and also the traffic situation and loss of real-time data in Torres Strait. This was reviewed at Reefcentre and audio tape copies of the radio messages between *Bunga Teratai Satu* and Reefcentre on 2 November were supplied by Reefcentre, through Queensland Transport.

The individual radar displays, the TIM information (both electronic chart and text display) and VHF traffic are all independently recorded and were made available to the investigation. The time base of the three recordings varied by about three minutes and the actual times of events could not be stated with absolute accuracy, but the sequence of events and time lapse is correct.

Information on the refloating of *Bunga Teratai Satu* was obtained through United Salvage and the Queensland Department of Transport.

The ship

Bunga Teratai Satu, together with other vessels in the company, is a regular caller to Australian ports. The ship presented as a well maintained vessel with a comprehensive management system.

Since 15 April 1998 the vessel had been subject to six Port State Control inspections, the last in Port Botany on 8 August 2000. The five inspections prior to 8 August had either recorded minor or no deficiencies and the ship had not been detained. On 8 August four deficiencies were found, three of them significant:

- frozen engine room ventilator dampers;
- inability to prove satisfactory operation of the GMDSS system; and
- a blown fuse on a lifeboat davit meant that the lifeboat could not be immediately retrieved.

The deficiencies were made good before the ship sailed.

On 15 November, after the ship was refloated, AMSA surveyors inspected the ship under the Port State Control provisions of the Navigation Act. The inspection was described by AMSA as 'very detailed' and carried out by 'two experienced surveyors'. The only deficiency found was a loose door seal on the forecastle head watertight door, which was required to be rectified at the next port.

Engine and steering trials were completed before leaving the anchorage off Fitzroy Island on 15 November. *Bunga Teratai Satu* sailed via Grafton Passage, taking the route outside the Barrier Reef to Sydney, where it arrived on Monday 20 December.

The mate

The mate went to sea as a cadet in 1973 with the Pakistan National Shipping Corporation. He left this company in 1981 to sail with a number of companies both Pakistani and foreign.

He obtained a mate's certificate in Singapore in 1997 and in 1998 he obtained a master's certificate. At the time he was working with a London-based shipping company, but this company reduced the size of its fleet. At that time MISC had been conducting interviews and the company selected the mate for its container ships, although he was more familiar with bulk cargoes. He had been employed by MISC since 21 September 1999.

In respect of the mate, his qualification and employment, MISC submitted that:

> …MISC had implemented all procedures under their (voluntarily implemented) Safety Management System to ensure the chief officer (mate) was suitably qualified and experienced to serve in the rank of chief officer before employing him. The chief officer's performance was monitored throughout his service with the Company in accordance with the Safety Management System. MISC are a safety conscious company who have implemented a Safety Management System on *Bunga Teratai Satu* in accordance with the ISM Code well in advance of the mandatory date for doing so. (The full MISC submission is included at page 28.)

His first ship with MISC was *Bunga Bedara* on a liner service from the Arabian Gulf to the Far East, from Karachi and Dubai to Shanghai via Singapore and Hong Kong. He joined *Bunga Teratai Satu* on 26 June, 2000 after a period of leave at his home in Karachi.

On the previous voyage, voyage 406, he complained of abdominal pains and expressed a wish to leave the ship when it returned to either Port Klang or Singapore. The master on that voyage arranged for the mate to see a doctor for his recurrent lower abdominal pain. The medical examination revealed no obvious or immediate problem, but recommended that, if his symptoms persisted, he should return home. The report stressed that he was currently fit for duties at sea.

After arranging for his wife to undertake a voyage on *Bunga Teratai Satu* he seemed content to remain on the ship for voyage 407, which would have been completed in late November. It was his wife's first voyage on a ship. Arrangements had to be made for his four children to be cared for by his mother-in-law in Karachi.

The master, who took command in Singapore on 26 October, stated that he detected nothing in the mate's ability as a watchkeeper to cause him concern or to doubt his ability to undertake routine watchkeeping duties, such as alterations of course in open waters.

Soon after the grounding the mate wrote a statement to MISC claiming abdominal pains had forced him to go to the lavatory after which he forgot to alter course. This account was repeated to the accident investigators but other inconsistencies in his interview, the AB's account and other evidence, such as the Telstra telephone records, made his evidence implausible. Later he gave a more plausible account to the Australian Federal Police and the Queensland Parks and Wildlife Service, before appearing in court to answer charges relating to breaches of the Great Barrier Reef Marine Park Act.

The reason for the timing of the telephone call at that time of the morning is not absolutely certain. It was two o'clock in the

morning in Karachi. The probability is that south of Fitzroy Island the ship would be out of range of mobile phone coverage for some time. The alternative would have been to place a call via the maritime system Inmarsat A at $6.30/min.

The grounding

Bunga Teratai Satu's GPS was normally on latitude/longitude display with the voyage plan programmed into the GPS. Cairns pilot ground was entered as waypoint 33 (16° 44'S, 145° 45'E) in the GPS. The arrival alarm sounded at the waypoint and was cancelled by the master. From the point at which the pilots disembarked to way point 34, in position 16° 52.8'S 146° 02.3'E, there was about 19 miles to run. Allowing time for the ship to work up to full speed, the ship would have reached the alter-course position (Fitzroy Light bearing 218° by 3.1miles) at about 0700 (fig. 2).

In case of congestion due to traffic an alternative course alteration position had been marked on the chart 1.7 miles beyond waypoint 34 (about 5 minutes at full speed). This position was not entered in the GPS and would not have triggered any alarm.

After the master left the bridge at 0635, the AB started to clean the bridge. This involved using a vacuum cleaner at some stage.

From the Telstra records it was established that the mate made an initial call on his mobile phone to the Telstra 'Phone-away' service at 0644:01. The call lasted for 2 minutes and 25 seconds. He made a further two calls, one at 0650:02 lasting 19 seconds and a further call at 0651:51 lasting 1 minute 17 seconds. The evidence suggests that it was after this last call that he phoned his wife from the console on the starboard side of the wheelhouse, asking her to come to the bridge. The master recalled that he heard the mate's cabin door close at about 0655. The mate's wife arrived on the bridge some minutes later.

The AB recalled that the mate and his wife went to the starboard bridge wing sometime before 0700, while he was using the vacuum cleaner. They closed the sliding door, he assumed, to stop the noise of the cleaner interfering with their phone conversation.

The Telstra records show that at 0703:55 a call was placed through the 'Phone-away' service with a duration of 10 minutes 45 seconds. The call finished at 0714:40.

Just before 0700 the AB finished cleaning the wheelhouse. At about 0700 he entered the GPS position in the GPS Log book as 16° 53.0'S 146° 02.4'E. He also completed some of the other information columns in the log taken from the GPS screen:

- 1252 miles to go to Sydney;
- current speed 20.1 knots; and
- 62 hours to run.

The plotted position, corrected to WGS[9] datum was about 500m south of waypoint 34, on the next track to waypoint 35. The plotted position was consistent with the ship's position as recorded in the Reefcentre system records of 16° 52.88' S 146° 02.28'E at a speed of about 21 knots. On this basis the GPS arrival alarm should have sounded at 0658:17; and the cross track error (XTE) alarm should have sounded at 0701:26.

The AB moved to a position at the front of the wheelhouse forward of the steering position and waited for the mate to re-enter

[9] Chart datum (GD 66) varies from GPS datum (WGS 84). Off Cairns, GPS plots have to be moved 0.09' south (167 m) and 0.05 m west (90 m).

the wheelhouse. Normally, when the AB fixed the ship's position the mate would check it. At this time the arrival alarm should have been sounding and it probably was. Also, the bottom line of the GPS display would have reverted to the course and distance to the next waypoint, waypoint 35, 164° by 97.2 miles from waypoint 34. The AB could not recall any alarm.

The mate's amended statement differs significantly from his original written statement and account of the events leading to the grounding. He stated that some time after 0640 he phoned Karachi to talk to his mother-in-law. He had phoned his wife to come to the bridge. After a brief conversation he handed the phone to his wife. She was on the bridge-wing and he stood in the doorway listening. The bridge-wing door was open. At 0700 he asked the AB to plot the ship's position and then reverted to listening to the conversation. He became distracted by the phone call and forgot that he was required to alter course.

At some time after 0715, probably about 0718, he went to the chart table. Initially he was disorientated, assuming the AB had marked the 0700 position on the chart wrongly, before he realised that he should have altered course. He ordered the AB to switch to manual steering and ordered an alteration of course to starboard to a course of 180°(T). Soon after the ship was felt to vibrate and the ship grounded.

At about this time the master arrived on the bridge and stopped the engine.

The mate, apart from being distracted by the phone conversation, apparently relied solely on the GPS navigator to fix the ship's position, ignoring navigation by visual cross bearing or radar. Although the GPS is very accurate such reliance does not allow for any cross-check for misread coordinates and leads to a lack of activity that increases the risk of poor watchkeeping habits. The Company's Bridge Watch Keeping Instructions (Appendix 1 to the Bridge Procedural Manual) require:

> 12. The watchkeeping officer shall periodically check the ship's course and speed, if conditions permit. Even if electronic navigation systems are used, the course shall be checked as far as possible, **using the compass and by check bearings and distances from the objects**. (Inspector's emphasis)

The Inspector accepts the MISC submission that:

> The situation that existed following the departure from the bridge of the master is that the vessel was navigating in good visibility in waters that were neither confined nor congested where one simple alteration of course was required by the (very experienced) officer of the watch. This alteration of course had a margin of safety of more than 7 miles before the vessel would run into danger (Sudbury Reef). This with a speed of 20 knots, gave more than 20 minutes for an error to be identified. (MISC submission, page 30.)

GPS

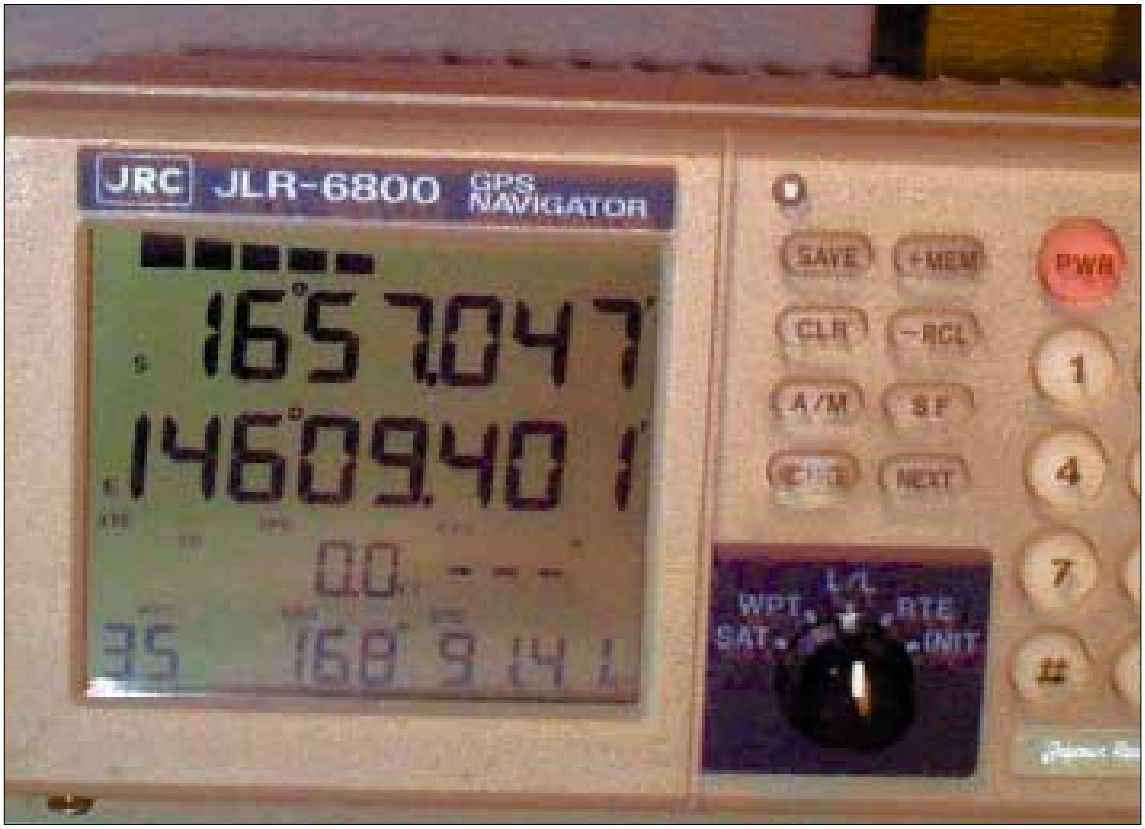
On 21 November, a specialist maintenance engineer examined the ship's GPS on behalf of the Inspector. (Figs. 4 and 5) No fault was found either in the aerial or in the receiver. The ship's staff stated that the GPS was functioning properly both before and after the grounding. It is therefore concluded that the GPS was working properly and there was no fault in the system at the time of the incident.

The Japan Radio Company GPS, a JRL6800, has six operating modes:

- the latitude/longitude mode (L/L) is the normal operating display;

Figure 4:
***Bunga Teratai Satu's* chart table**

Figure 5:
***Bunga Teratai Satu's* GPS**



- initialisation mode (INIT) allows entry of gyro and log data;
- waypoint mode (WPT) allows the programming of up to 200 waypoints;
- route mode (RTE) is used to select a route or way point and set alarms;
- satellite mode (SAT) displays the satellite data;
- special feature mode (SF) is used to set up special operating modes.

The RTE mode allows any of four alarms – 'arrival'; 'anchor watch'; 'off course'; and 'boundary'. The arrival alarm may be set at a pre-designated distance from the waypoint to alert the navigator. The arrival alarm must be cancelled at the GPS receiver. Once the waypoint has been passed the GPS will automatically revert to the next waypoint. The GPS will constantly update the course and distance to the next waypoint. If a vessel deviates from the new track by a pre-determined distance the XTE alarm will sound and the letters 'XTE' will display at the lower third, left side of the display. The maximum value that can be programmed for any of the alarms is 9.9 miles. The alarms will sound regardless of the position of the mode operating switch.

The GPS receiver on *Bunga Terati Satu* was programmed for the voyage from Singapore to Sydney. The arrival alarm was set for 0.6 miles and the XTE was set at 0.5 miles. Examination of the GPS on 21 November, and confirmation that the set and its alarms were operational both before and after the grounding, would suggest that the set was fully functional between waypoint 33 and the grounding position.

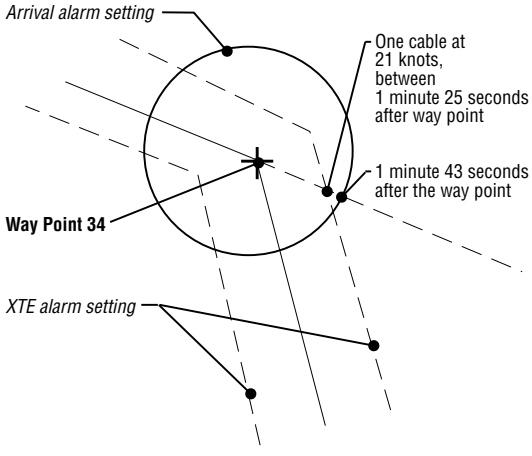
With the setting of the arrival alarm at 0.6 of a mile and the cross track error at 0.5 of a mile, there was a period of about 18 seconds in which the XTE alarm would have been operating at the same time as the arrival alarm. JRC advised that the two alarms would sound and each would have to be cancelled individually.

It should be pointed out that the GPS alarm is not loud and is identical for all alarm conditions. The alarm cannot be heard on the bridge wing, or over the noise of the vacuum cleaner when the bridge is being cleaned. Also it is similar to the Digital Selective Call alarm, part of the GMDSS system, which was located a few metres from the GPS.

In submission (page 33) MISC dispute the assertion that the alarm was not loud enough to attract the mate's attention.

There is no clear evidence as to when any audible alarm was cancelled at, or near waypoint 34. The arrival alarm would have sounded just after 0658 and if it had not been cancelled, would have continued sounding until the XTE alarm was finally cancelled after the grounding. The AB could not recall either the alarm or the mate being inside the wheelhouse after the time his wife arrived on the bridge. The mate stated that he cancelled the alarm, although it is not

Figure 6:
Diagram showing GPS urgent alarm times



clear if this took place at 0700, or after 0715 when he checked the ship's position following the phone calls.

Defences

Safe navigation depends upon a number of shipboard and external defences, which allow a system to operate safely, reduce the likelihood of an unsafe act or condition and mitigate the effects of any unsafe act. These defences include the training and competency of individuals, shipboard procedures and the alarm systems on radar and GPS, as outlined above. External to the ship, defences include reporting systems, tidal information, sailing directions, lighthouses, buoys and beacons.

Safe navigation depends upon the proper watchkeeping of the bridge team, particularly the professionally qualified officer of the watch.

The mate created an unsafe condition by allowing himself to be distracted by the phone call, a very serious professional lapse. The lapse resulted in a situation in which all the existing on-board defences or barriers were negated resulting in the grounding. The presence of the mate's wife on the bridge should be kept in perspective and should not be overstated. Her presence of itself did not cause the mate's inattention, rather it was the use of the telephone.

In analysing accidents with a view to preventing similar occurrences it is normal to examine what defences failed and why, and what defences were not in place that may have prevented the accident. Such an approach recognises that people do commit unsafe acts for a variety of reasons. The examination of defences in no way excuses individual or collective unsafe acts nor does it imply any reduced responsibility.

Shipboard defences

Procedures and instructions

Company procedures, instructions and master's standing orders should provide for a framework of safe ship operation. As noted earlier, being a container ship *Bunga Teratai Satu* is not required to conform to the provisions of the International Safety Management Code until 2 July 2002. MISC, however, have a number of tankers and other ships that are required to comply and all ships in the fleet effectively conform to the common safety management regime. *Bunga Teratai Satu* carried comprehensive operating procedures issued in January 1997, supplemented by the master's standing orders.

A section of the Company procedures related directly to bridge procedures. There was no record of any revision to the Bridge Procedures Manual since its issue in 1997. The document provides for the management of a navigational watch, leaving and entering port, procedures to be followed in heavy weather, navigation in narrow channels, navigation in restricted visibility and navigation in cold areas.

The procedures referenced the second edition (May 1990) of the International Chamber of Shipping Guide, although the third edition (1998) was carried on board. *Bunga Teratai Satu*, however had the required passage plan drawn up. The plan designated waypoint numbers, waypoint positions, the true course, distance to the next waypoint and the distance to the destination, in this case Sydney. The procedures made provision for navigation in narrow channels (3 miles or less in width), congested waters and the open sea. The procedures do not provide for coastal navigation. South of Cairns the ship was in 'open waters'.

The procedures require, amongst other things:

> The watchkeeping officer shall check course, position and speed every 30 minutes or sooner depending upon the situation using GPS, NNSS, Log, Radar, Compass and etc. to ensure that the ship maintains its planned route.

It was accepted by the master that a normal competent watchkeeping officer would fix the ship more frequently than every 30 minutes, in line with the company procedures. The frequency of fixing had been every 15 minutes until the master left the bridge at 0635.

Procedures are an important part of any operational safety system. They are however, also one of the least effective forms of safety assurance. Procedural documents do not usually make interesting reading. Individuals may not read them properly or they may overlook or forget provisions. Intentional non-compliance with procedures (violations) is a major safety problem and may be involved in up to 70 per cent of accidents in some industries.[10]

The company's bridge procedures were generally adequate. The situation was routine and the mate knew what he should do. The ship's officers accepted that frequent fixing was necessary and more precise instructions would not have altered the outcome.

Bridge resource management

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended in 1995, specifies as a minimum standard of competence for officers in charge of a navigational watch. Competence to maintain a safe navigational watch includes:

> (a) thorough knowledge of effective bridge teamwork procedures.[11]

Bridge resource management is a system whereby the operation of the bridge team is enhanced as an integrated unit to reduce the possibility of single person error. Such an arrangement requires a culture where junior or less well qualified members of the bridge team can 'challenge' a senior person without a negative 'response'. The idea of challenge and response is an important defence.

The company procedures made specific reference to the role of the look-out:

> The responsibility of the look-out shall be to maintain an appropriate watch for adequately understanding the situation in which the ship is placed and hazards during navigation such as collision and grounding; in addition, the look-out shall detect ships in distress and wrecks and debris.

Bridge resource management did not exist to any effective extent on *Bunga Teratai Satu*. The mate, though appropriately qualified was distracted by the phone call and lacked the proper level of motivation to operate in a professional manner.

The AB, although aware that the ship had passed the alteration point, did not feel that it was his place to suggest to the mate that he should alter course. There was also some ambiguity as to where the ship was to alter course off Fitzroy Island. The chart showed two positions, waypoint 34 and an alteration point 1.7 miles further east on the 118° heading (Figs. 2 and 3). From waypoint 34 a

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[10] S. Mason, Procedural Violations – Causes, Costs and Cures, in F. Redmill and J. Rajan (Ed) *Human Factors in Safety Critical Systems,* London: Butterworth Heinemann, (1997).

[11] STCW Convention, Table A-II/1, London: International Maritime Organization (1996) pg. 30.

course line of 164° was drawn and this was noted in the voyage plan as the course alteration point. The second alteration point required an alteration to a heading of 169° and beside the course line on the chart was notated:

> recommended if any traffic

The second alteration point was not shown on the voyage plan. There was no traffic that day to impede *Bunga Teratai Satu*. The Inspector is satisfied that waypoint 34 was the intended alteration position and the second position was a fall-back position in case of traffic.

The AB was obviously an intelligent young person with some six years seagoing experience. He had learnt to plot GPS positions but was not familiar with chart symbols or issues such as scale, or time/distance estimations. He did not realise the ship was standing into danger. He resumed his lookout duties assuming that the mate would make the appropriate alteration in due time. The master accepted this attitude as quite normal and proper.

This is neither a criticism of the master, who had no experience of any different system of bridge organisation, nor of the AB. Such an attitude reflects a large 'power-distance' index[12], a strict hierarchy, between the senior officers and junior officers and crew. This is seen as quite normal and proper in some organisational systems, but such a working environment increases the likelihood of a one-person error.

In submission MISC submitted, amongst other things that:

> …the AB can be expected to perform only those functions that are within his area of competence and training (as an AB). (MISC submission page 33)

The mate's distraction over a prolonged period effectively by-passed the ship-board defences, which were more limited than they could have been.

External defences

Pilotage

Pilotage is compulsory in the area of the inner route between Torres Strait and 16° 40' S (just south of Low Isles and Trinity Entrance).

Although the Great Barrier Reef extends for a further 520 miles, to the south east of Cairns, pilotage is not compulsory in this area. A risk assessment relating to oil spills in Queensland waters notes:

> Navigational difficulty for mariners decreases as the ship moves south down the eastern seaboard from Torres Strait. The coastline south of Cairns to Gladstone presents less difficulty than to the north of Cairns and the coastline south of Gladstone once outside the GBR to the New South Wales border is reasonably simple with ample sea room and vessels are far less constrained by draught.[13]

Navigable water between Cairns and Sandy Cape is at no point less than 5 miles wide in depths of more than 15m. In all there are about six course alterations, with none of the alterations being greater than 48°.

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[12] G. Hofstede, Cultures and Organizations: Intercultural Cooperation and its Importance for Survival, (London: Harper Collins, 1994), p 26.

[13] Oil Spill Risk Assessment for the Coastal Waters of Queensland and the Great Barrier Reef Marine Park, (August 2000), Queensland Transport and the Great Barrier Reef Marine Park Authority, pg.31.

A detailed study of pilotage in the inner route of the Great Barrier Reef is currently being undertaken jointly by AMSA and the Queensland Department of Transport.

Lights and beacons

From Grafton Passage to the south east extremity of the Great Barrier Reef at Hixson Cay, where there is a racon[14], there is only Rib Reef light beacon at the inner end of Palm Passage marking the east side of the passage of the inner route. Creale Reef light in Hydrographers Passage is 36 miles off the track of the inner route. There should be no need for marks on the east side of the channel as there are lights and prominent radar targets with which the ship's position can be fixed. Also, as in the case of *Bunga Teratai Satu* most ships now have the capability of fixing their position with utmost accuracy by GPS.

However, much of the reef south of Grafton Passage is submerged at all states of tide. There are therefore few features to the east of the track to give a visual reference of the reef edge.

From the time the master left the bridge at 0635, when Green Island was just forward of the port beam, the ship was travelling towards a featureless horizon with no visual cues to mark the reef, which was largely submerged. Had there been something such as a beacon to stimulate the mate from his reverie or alert the lookout then they may have reacted to save the situation. As stated above, if the mate was conducting himself properly such a consideration should not be necessary. But he wasn't.

Reefcentre

The responsibility for safe navigation rests with the ship. Reefcentre operators are not qualified navigators. Their role is to provide relevant information to the ship-board decision maker. The SRS/Reefrep procedures manual requires operators to use the radar as well as the TIM to provide ship traffic information.

Marine Orders Part 56, 'REEFREP', provides that a master is obliged to report in the format provided and states:

> …It should be noted, however, that provision of such information does not in any way relieve the crew of the ship, or a pilot, from their normal responsibilities in relation to the navigation of the ship. In particular, it does not relieve the crew of a ship from keeping a proper look-out in accordance with Rule 5 of the Collision Regulations.

While the area of radar coverage is limited and the radars do not perform a precision track monitoring or precision collision avoidance function, the SRS has to ensure that, subject to the availability of suitable data, essential information becomes available in time for on-board decision making. Reefcentre has an obligation to provide the ship with timely essential safety information. Standard operating procedures issued on 16 April 1999 provide guidance for the Reefcentre operators. These include the use of radar to prevent grounding (at 5-3-7, 5-3-8, 5-3-9, 5-3-10, 5-3-17, 5-3-18 and 5-3-19):

> 7. The STS Service is not a navigation assistance service where the service directly assists the on-board navigational decision making and monitors the effects of that assistance.
>
> 8. Reefcentre VTSOs do not provide navigational assistance or give navigation direction but they do provide certain navigation information.

[14] Racon – radar responder beacon.

9. The SRS radars, in conjunction with the TIM (Traffic Information Module), are required to be carefully monitored so that developing on-water situations that might adversely affect participating ships can be identified while there is still time to bring the information to the attention of the on-board decision maker for it to be of use in a situation where the ship appears to be running into danger.

10. An example of where this might occur is in the case of a clearly defined course alteration point on a definite and well established track, in an area where the radar performance is such that it is evident that an error in the navigation of the ship is taking place resulting in the ship not making the turn at a course alteration point and thus running into danger.

17. Radar provides a significant benefit to the SRS and gives the ability to better interact with participating ships – interaction is a key requirement of IMO for SRS. The availability of radar data to generate radar collision alerts and TIM grounding alerts is an important safety feature within the system.

18. REEFCENTRE is required to provide a measured response to a developing situation detected by radar. This requires careful use of system generated alerts. Alerts must be checked to establish their cause, and if the situation that created the alert continues to develop, a warning must be communicated to the participating ship or ships involved.

19. In the event that a grounding alert is generated by a ship which continues to remain marginally within a TIM 'restricted area', the situation is required to be closely monitored and if the ship proceeds further into the restricted area a warning is required to be delivered. In marginal situations it is prudent for REEFCENTRE to delay delivering the warning while closely monitoring the situation to see if it develops further.

The procedures recognise that an operator may observe a ship involved in entering an area of shallow water. In such a case, consistent with the SRS being an information service the procedures require (SRS/Reefrep 5-4-4):

4. In the event of a developing situation observed on radar the operators must contact the relevant participating ship/s and provide warnings to these ships. Note: It is the responsibility of the on-board decision maker (Master/Pilot/navigating officer) to make decisions regarding the navigation of the vessel.

Risk of grounding

Risk of grounding warnings are used only in areas of radar coverage. Restricted areas (polygons) have been identified in the TIM in those areas. These areas enclose shallow water at the limits of fairways and channels along TIM legs. An operator alert is activated on the TIM when a ship whose radar track has been transferred from the RSM[15] to the TIM enters one of these Restricted Areas, i.e enters an area of shallow water (see Section 5-5).

Risk of grounding warnings are delivered on Channel 16 thus:

…Warning. According to my radar you are running into danger, shallow water ahead.

Since August 2000, to the date of the grounding on 2 November, Reefcentre has had cause to alert ships on four occasions that they were standing into danger. Two of the ships were navigating Torres Strait; one ship approaching Stagg Patches (close east of Sudbury Reef); and the other off Mackay. All were unpiloted.

How, then, was the failure of *Bunga Teratai Satu* to alter course, its subsequent entry into the restricted area and grounding missed?

[15] RSM – Radar Systems Module

.

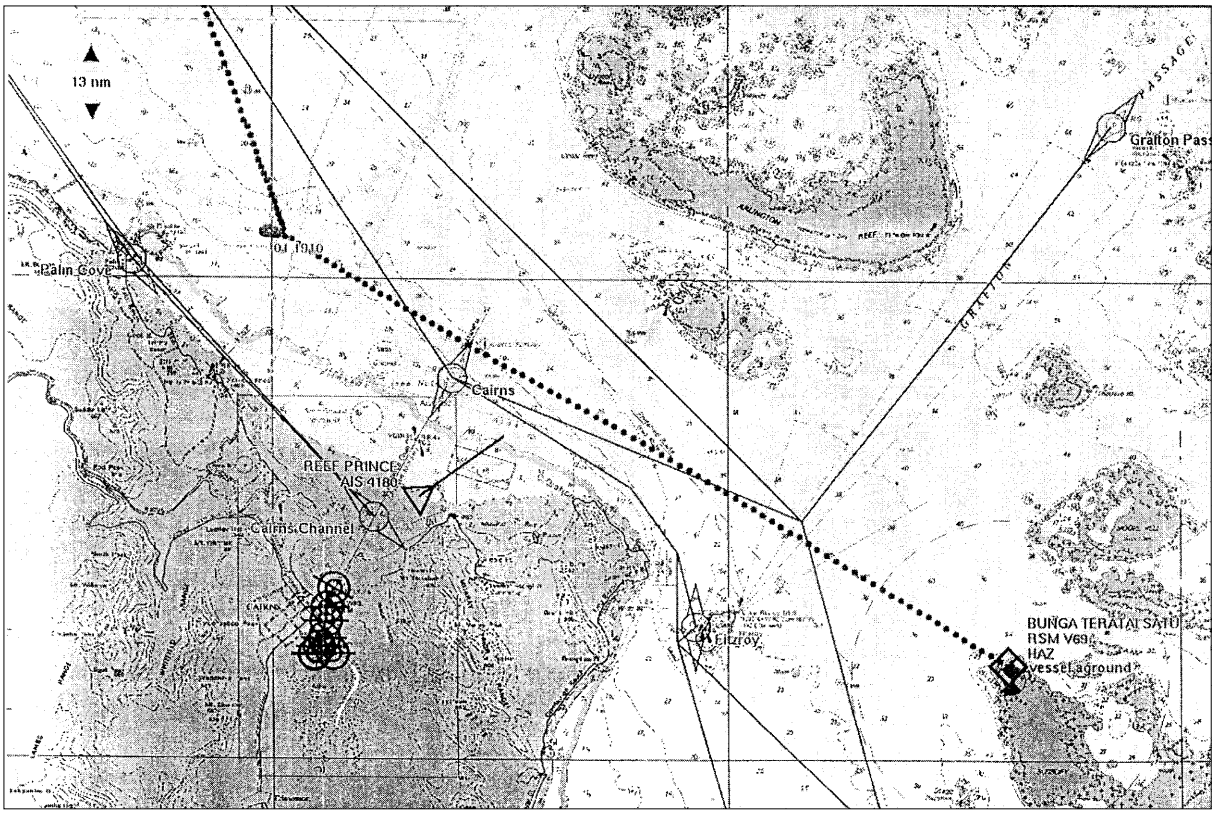
From evidence obtained through the system records, between 0700 and 0730 three alert messages were generated. Two of these were 'routine' at 0701:46 and 0716:01[16].

The 'urgent' alert message indicating *Bunga Teratai Satu* had crossed into the restricted zone off Sudbury Reef was timed at 0715:50.

Twenty-two seconds before *Bunga Teratai Satu* entered the restricted zone, the Reefcentre Hammond Island radar monitor lost the radar echo of *Jin Hui*. The operator's attention was immediately focused on Hammond Island radar and the Sirius display of Torres Strait. With subsequent loss from the radar of the real-time echo from two other ships in the Torres Strait, the operator remained focused on the Hammond Island display for some ten minutes. The urgent alert message box on the Sirius display did not register and had gone unnoticed. It was about 15 minutes after the grounding, after the operator had re-fused the targets in Torres Strait and worked VHF traffic until about 0732, that he realised something was wrong.

However, the system management records show *Bunga Teratai Satu* had passed its waypoint marginally before 0700. There was a period of about 15 minutes, in which the ship maintained a steady course for 5 miles deviating from its planned track before entering the restricted area and triggering the urgent alert message (fig. 7). The circumstances envisaged in 5-3-10 of the

Figure 7:
***Bunga Teratai Satu's* track on Sirius**



[16] The clocks on the three systems (TIM, VHF/Telephone recordings and radar displays) were not synchronised but the three were within two minutes of each other. The time shown accurate to the second is taken from the TIM database

standard operating procedures would appear to apply.

Reefcentre records show that between taking over the watch at about 0655 and 0713 the operator had been continuously involved in routine SRS operations (VHF, TIM and radar). The navigation in the area is not complicated and a person with the most rudimentary navigational knowledge could be expected to alter course off Fitzroy Island. Without any special stimulus the operator did not pay any extra attention to the Green Island radar display.

Unless the operator had specifically looked at the Green Island radar display during this time he would not have realised that Bunga Teratai Satu had failed to alter course.

The display of an alert message on TIM, of itself, was such a routine event that it would not necessarily have resulted in the operator adopting a heightened state of alertness, or giving it priority over re-establishing the Torres Strait radar/TIM display. In the event of an alert, the system gives a normal computer prompt, a single audible 'bleep', that a message has been generated. There is no indication until the message is accepted on TIM of the level of urgency, or which of the 17 alert messages is indicated, or the location of the alert.

The workload for operators is not uniform and depends upon the number of ships in the system. There are times of intense activity communicating with multiple ships entering the system at the same time and fusing targets. At other times activity is less intense. But there is always a level of VHF traffic that needs to be monitored and ship positions, requiring updating. Heightened activity can also be caused by failures or partial failures in the system. A further workload is generated by the system alarms generated by TIM and from the radar display. A number of these are either spurious or relatively low priority alarms.

System statistics show that in the calendar year 2000, there were over 7400 restricted area alerts, or just about one each hour of operation. There are also separate alarms generated by the four radar displays. One operator estimated that in a twelve hour shift there may be over 100 alerts. The most common area for such alerts is the Torres Strait. The overwhelming majority of such alarms, while not spurious, do not indicate a vessel standing into danger. Most alert messages generated by the system relate to collisions (usually with buoys) or transient entry into a restricted area.

The sheer volume of alerts desensitises the operators to the alert messages and alarms.

The restricted area urgent alert message was displayed at 0715:50. Given the container ship's speed of over 20 knots and the level of attentiveness evident on the bridge of *Bunga Teratai Satu*, it is doubtful that a warning issued as the vessel crossed into the restricted area would have averted the grounding. To make initial contact with the ship, the Reefcentre operator would have had to tune the Reefcentre VHF to channel 16. The mate on watch would have had to receive, understand and react to the message in sufficient time to turn the ship away from the danger. The ship under full rudder would have advanced about 4 cables and transferred laterally some 5 cables. Given the two mile restricted area, the mate would have had to have responded and acted positively within four minutes of crossing into the restricted zone.

The Queensland Department of Transport submitted:

> Clearly the prime task of Reefcentre is to receive reports from participating ships and to provide information about shipping traffic to

these ships. The prime purpose of the radars is to confirm the position of reporting ships and to identify non-compliant ships. This was the task on which the operator was engaged in Torres Strait, an identified high-risk area. It will be most unfortunate if this report identifies him as contributing in any way to a marine incident so clearly caused by a dereliction of duty on the part of the ship's watch keeping officer.

Once again I would urge that the final report reflect that the Reefcentre had no role in the grounding of Bunga Teratai Satu.

It was a malign chance that there should be a short period of intense activity in Reefcentre just as Bunga Teratai Satu had entered the restricted area and while it headed towards the reef.

Reefcentre – Reliability of radar system

During the course of the investigation some suggestions were made that the radar system lacked the reliability to track and monitor vessels. The system was not primarily designed as a vessel advisory service or to conform with the reliability standards of the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA).

In setting up the radar surveillance system, the project document specified performance of each of the radars, for which AMSA was responsible, on the basis of availability. The tender document called for 98 per cent availability.

Reefcentre records of radar faults from or at the four radar sites for the seven months from 1 June to 31 December 2000 amount to 15 reports of some description or one fault every 12 days. Of these, eight reports related to the Hammond Island radar, four to Green Island, two to Penrith Island and one to Warraber Island. The records indicate that four of these faults were reported to AMSA in relation to its responsibility under the bi-party Reefcentre agreement.

AMSA's navigation network performance* report for the period 1 June to 30 November shows, that in the 183 day period, the radars at:

- Hammond Radar failed twice with a total down time of two days,
- Warraber Island failed on one occasion for one day, and
- Penrith Island failed twice for a total of three days.

Each of the three radars was available for over 98 per cent of the period with availability ranging from 98.36 per cent at Penrith Island to 99.45 per cent at Warraber Reef.

The AMSA figures relate only to the radar site equipment and do not account for faults down-line of the radar. Other faults have occurred from time to time and there were some differences between the Reefcentre figures and the AMSA data on these. Such faults have included intermittent loss of targets and tracks, similar to the problems experienced by the operator on the morning of 2 November. These faults tend to undermine the operator's confidence in the system and add to the operator workload.

The evidence is that faults either at the four radar sites or elsewhere within the system are addressed as a matter of priority.

REEFREP is an effective and innovative ship monitoring system covering some 1200 miles of coastline. The radar element

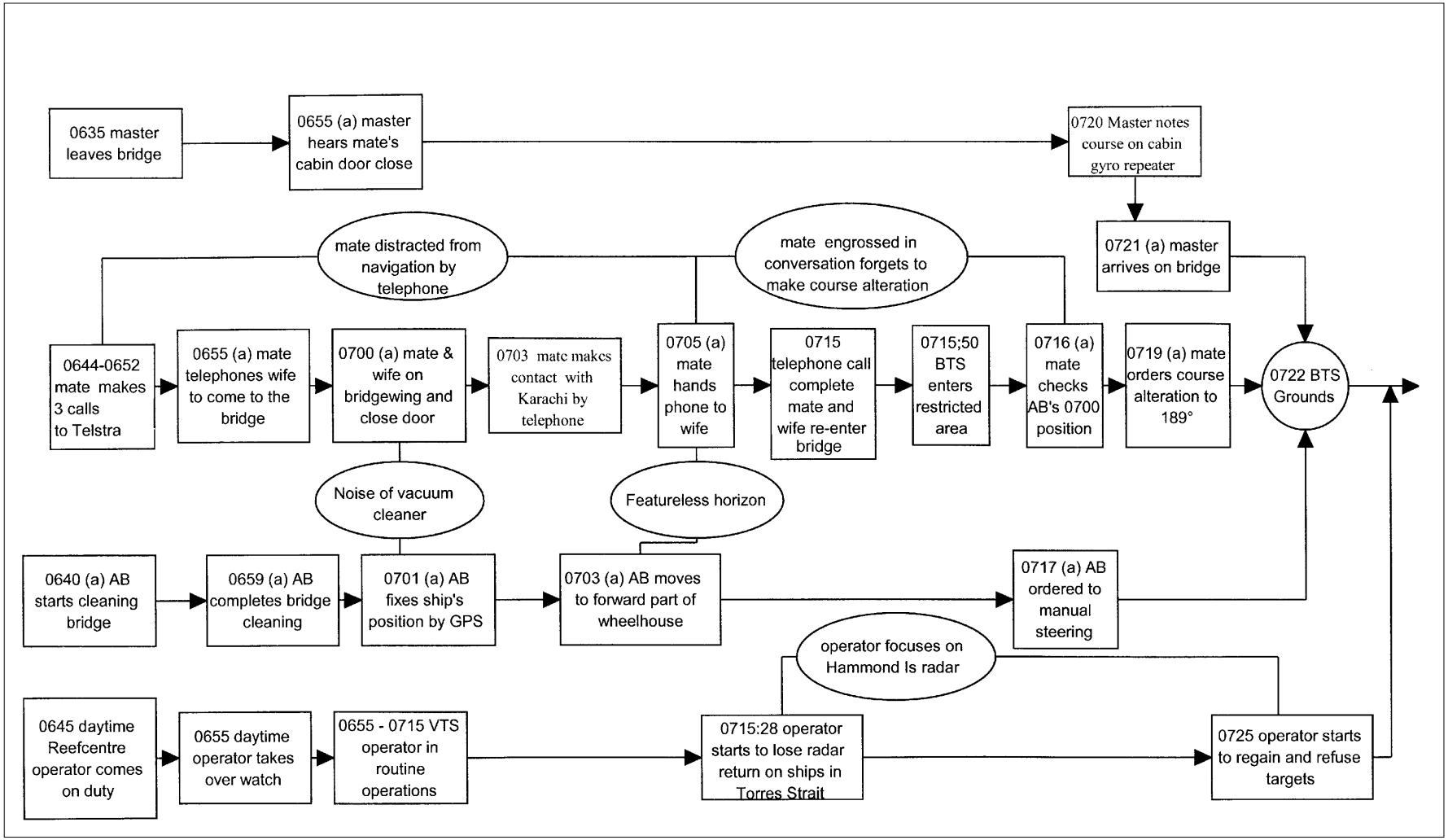
* Note - Green Island radar installation is maintained by the Queensland Department of Transport and its avaliability does not appear in AMSA performance records.

of the system has worked within its design availability envelope, despite the remote locations involved and an environment hostile to electronic systems.

Drugs and alcohol

Bunga Teratai Satu is a ‘dry’ ship. The Inspector is totally satisfied that neither alcohol nor drugs, prescribed or illicit, were taken by any of those involved in the grounding.

Figure 8:
***Bunga Tertai Satu* events and causal factor chart**



Conclusions

These conclusions identify the different factors contributing to the grounding of *Bunga Teratai Satu* and should not be read as apportioning blame or liability to any particular individual or organisation.

1. The significant unsafe act that resulted in the grounding was that the mate allowed himself to become distracted, for a period of about 15 minutes, from the navigation of the ship by a telephone conversation between his wife, who was on the ship's bridge wing, and his family overseas.

2. From about 0645 to 0715 the mate had become preoccupied with arranging and making private telephone calls while the ship was in cellular phone range of the coast, rather than monitoring the ship's course, speed, position and his other watchkeeping duties.

3. The manner in which the mate maintained his watch on 2 November 2000 lacked appropriate motivation and fell well below proper professional standards.

Based on the evidence available, the following underlying, or 'latent', factors are considered to also have contributed or are relevant to the incident:

4. The ship's GPS cross-track error alarm was neither loud enough nor strident enough to attract urgent attention.

5. The absence of an appropriate level of Bridge Resource Management on the vessel allowed a basic error by one person to result in a serious accident.

6. The Reefcentre operator was aware that *Bunga Teratai Satu* was in the area of the Green Island radar coverage, but the loss of radar signal of vessels in Torres Strait caused him to focus solely on the Hammond Island display and to concentrate on re-entering the information into the Traffic Information Module.

7. The frequency of annunciation of Traffic Information Module alarms and associated radar alarm systems had led to the desensitising of Reefcentre operators to the whole TIM alerting system.

8. However, given the setting of the restricted area off Sudbury Reef at two miles and the speed and circumstances prevailing on the bridge of *Bunga Teratai Satu*, it is unlikely that any advice provided by the Reefcentre operator under the Reefcentre procedures would have prevented the grounding.

In relation to the perception that the radar system was not reliable:

9. The radar units operated consistently within the design availability criteria.

Recommendations

To the ship operators

Review the feasibility of introducing Bridge Resource Management principles to ship operations and particularly navigation.

Investigate the advisability of allowing private mobile telephone usage on the bridge when the navigation is in the charge of a single officer.

Review the ship operating procedures with a view to adopting appropriate current Chamber of Shipping Guidelines.

Examine the feasibility and advantages/disadvantages of fitting audible GPS alarms in positions other than at the GPS display.

In conjunction with equipment manufacturers, review volume and characteristics of critical GPS alarms.

To Reefcentre

Review the ‘alert’ message system, the prioritising of messages and the current extent of restricted areas south of the compulsory pilotage zone.

Review the role of Reefcentre and the current ship reporting system to determine the feasibility of providing a full advisory service.

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 was sent to the following:

Malaysian International Shipping Corporation

The master *Bunga Teratai Satu*

The mate *Bunga Teratai Satu*

The Ship Reporting System operator, Reefcentre

Australian Maritime Safety Authority

Department of Transport - Queensland

In response to the submissions the text has been amended where appropriate, otherwise the parties' response is as follows:

Malaysian International Shipping Corporation

(Additional comments are contained in the text of the report.)

> We note your comments regarding bridge resource management and have the following response:
>
> On page 6 of the report the Inspector comments that the Chief Officer 'had earlier asked the AB to plot the 0700 position'. Had the Chief Officer ordered the AB to plot the position then there would be an obligation on the AB to report to the Chief Officer that he had done so. It is our understanding from the various detailed interviews with the Chief Officer and AB that the AB took the 0700 position and plotted it on the chart entirely on his own initiative. The AB did this because he noted that the Chief Officer was engaged with his wife at the bridge wing.
>
> On looking at the chart the AB had no indication (from the chart or otherwise) that the vessel had passed an alteration of course position; indeed the appearance of the chart indicated that at 0700 the alteration of course position had yet to be reached. We have included for your ease of reference a copy of the chart illustrating this. The Inspector notes that the AB (as one would expect of an AB) has no knowledge of scale and distance and therefore the time it takes the vessel to reach any particular point. As such, he could not of course be expected to have known how long it would take to reach the apparent alteration of course displayed on the chart. On this basis the AB had no imperative reason to draw the Chief Officer's attention to the 0700 position. We believe it is unreasonable to criticise the AB for failing to call the Chief Officer on a navigational issue. Bridge team management does not usually require the AB to check the watch officer's navigation as, by definition, an AB cannot be expected to have the skills or the experience required to perform this function.
>
> The criticism of the Master in accepting the above situation and the description of this as reflecting a 'large power distance index' is in our own view quite unfair and fails to take account to the reality on board most ships in terms of the working relationship between different ranks/ratings, bearing in mind relative abilities, experience, knowledge and roles.
>
> The situation was such that the ship was not in confined or congested waters, and therefore one straightforward alteration of course, with a safety margin of 20 minutes before running into a danger, should be no more than could reasonably be expected of a Chief Officer with so many years of experience, and a Master's foreign-going licence.
>
> We would be grateful if the relevant comment in the report could be removed or otherwise modified to more accurately reflect the reality of the situation.

Report Conclusions

A. In the Conclusions, paragraphs 1 and 2 refer to the Chief Officer's navigation watchkeeping. It is fully accepted that the grounding occurred due to the Mate's lack of attention to the navigation of the vessel for a period due to being distracted by the telephone conversation between his wife and her mother. Although (like the position with most of the world's major shipping operators) no written instructions existed on board MISC vessels prior to this incident specifically concerning the use of private mobile telephones on the bridge, neither MISC nor the Master were aware, or gave permission for the Chief Officer to make use of his mobile phone during his bridge watchkeeping. Please note that the Chief Officer was not personally talking on the mobile telephone (he was listening to his wife), accordingly, the distraction was not caused by his own use of a mobile telephone.

MISC fully accept point 3 referring to the manner in which the Mate maintained his watch which clearly fell well below proper professional standards (and his own previous standards – clearly this was a one-off incident of negligence on his part). However to put the matter in context and give a balance view we feel that some express recognition should be made in the report of the fact that the Chief Officer was extremely experienced (with over 20 years at sea, held a Certificate of Competency one grade higher than the rank in which he was serving (this certificate was issued by an authority recognised by IMO as issuing certificates of acceptable standards) and had been sailing on the Bunga Teratai Satu for the previous four months with no adverse comments from his current or previous Masters on his watchkeeping performance. Furthermore, MISC had implemented all procedures under their (voluntarily implemented) Safety Management System to ensure that the Chief Officer was suitably qualified and experienced to serve in the rank of Chief Officer before employing him. The Chief Officer's performance was monitored throughout his service with the Company in accordance with the Safety Management System. MISC are a safety conscious company who have implemented a Safety Management System on Bunga Teratai Satu in accordance with the ISM code well in advance of the mandatory date for doing so (1 July 2002).

B. While we note the Inspector's personal opinion that the GPS cross track error alarm was not loud or 'strident' enough to attract urgent attention, the alarm was (and still is) demonstrably loud enough to be heard throughout the wheelhouse. The fact that the Chief Officer chose to ignore the alarm (and may have ignored the alarm at whatever volume it had sounded), this is surely a failure not of the equipment or the management of the vessel but of the Chief Officer himself.

C. Concerning point 5, we do not concede that there were or are any lack of bridge resource management principles on Bunga Teratai Satu. As commented above, the AB has no training nor is he required to have any training (under the STCW Convention or otherwise) in the actual navigation of the vessel. In bridge resource management the AB/lookout/helmsman can be expected to perform only those functions that are within his area of competence and training (as an AB). In this case the AB questioned the advisability of altering course to starboard when he could see a sand cay on the starboard side of the vessel. In our opinion, this indicates that the AB (within the area of his competence) was in fact acting fully in accordance with good principles of bridge resource/team management.

The situation that existed following the departure from the bridge of the Master is that the vessel was navigating in good visibility in waters which were neither confined nor congested where one simple alteration of course was required by the (very experienced) officer of the watch. This alteration of course had a margin of safety of more than 7 nautical miles before the vessel would run into danger (Sudbury Reef). This, with a speed of 20 knots, gave more than 20 minutes for any error to be identified. The vessel, under normal operating conditions in open sea may have far less time than this in which to react to a danger yet we would not expect criticism to be levelled at bridge resource management if an officer of the watch, under such open sea conditions, failed to take action where a safety margin of a similar order existed.

In good bridge resource team management a Master assesses the navigation tasks ahead and assigns the appropriate resources to the task. In this case the Master was we believe, quite correct in assigning one suitably qualified and experienced deck officer to the task – no more resources were required. We assume that there is no suggestion that the Master ought to have remained on the bridge throughout the voyage to Sydney or that he should have 'doubled' the watchkeeping officers on the bridge for a straightforward coastal passage. We would therefore ask you to seriously reconsider this point.

Queensland Department of Transport

A submission made by the Department is included in the text of the report.

Bunga Teratai Satu

IMO Number	9157662
Flag	Malay
Classification Society	Lloyd's Register
Ship Type	Container
Builder	Daewoo Heavy Industries
Year Built	1997
Owner and manager	MISC BHD
Gross Tonnage	21 339
Net Tonnage	8940
Summer deadweight	24 612 tonnes
Summer draught	10.218 m
Length overall	184.00 m
Breadth	27.40 m
Moulded depth	15.80 m
Engine	B&W 6S60MC
Power	12 260 kW
Crew	32

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