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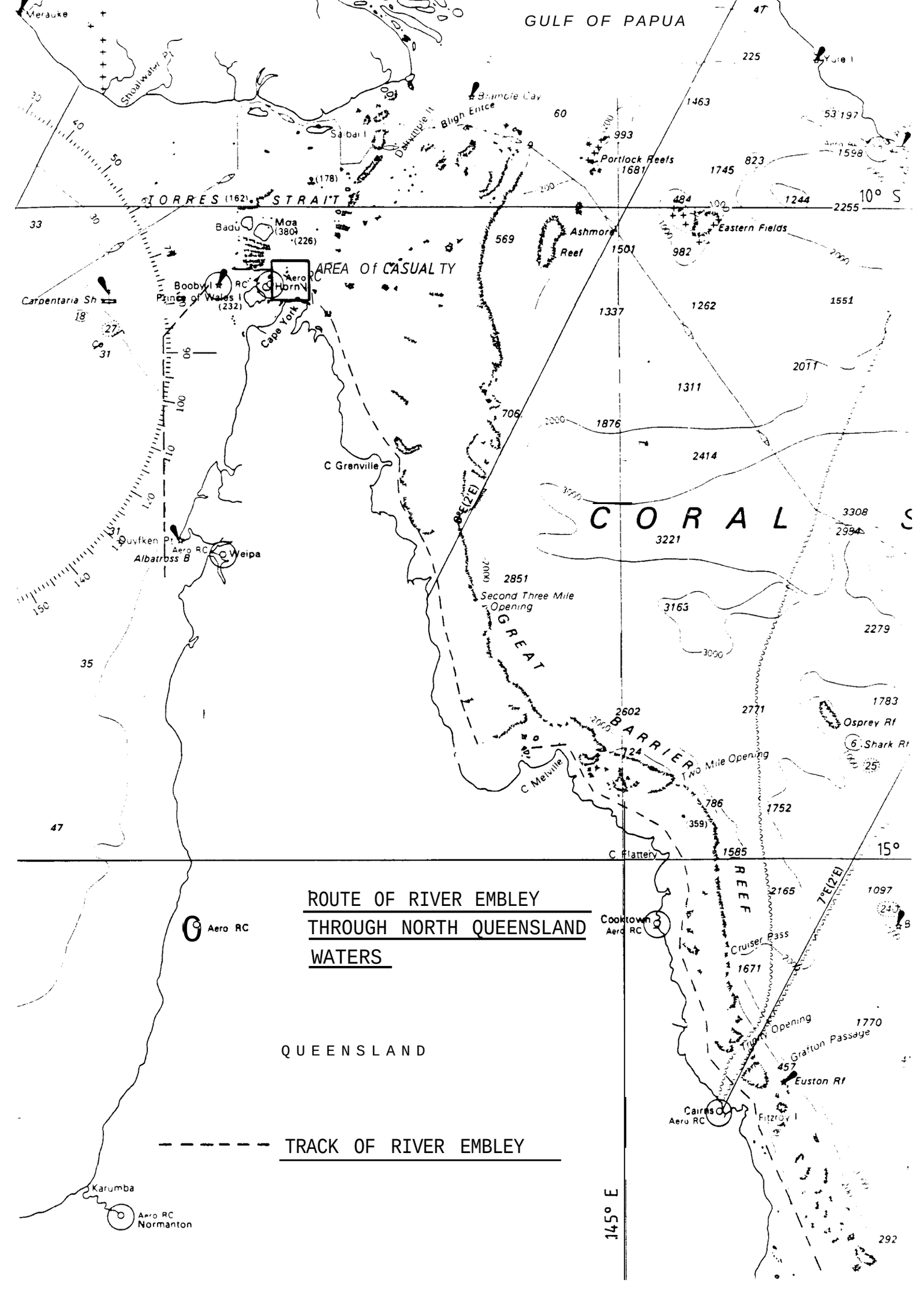
OUTLINE OF INCIDENT

Shortly before 1700 hours Eastern Standard Time on 9 May 1987 the Australian flag bulk carrier RIVER EMBLEY, on passage from Weipa to Gladstone, grounded momentarily south of Alert Patches Buoy in the eastern approaches to the Prince of Wales Channel, Torres Strait. The vessel sustained damage forward and commenced to flood the forepeak and No 1 void space. The reported position of the grounding was not immediately fixed but was subsequently deduced by ship staff.

The ship, loaded with bauxite, proceeded to a safe anchorage. The flooding forward stabilised and temporary repair work was effected to allow the ship to proceed to Gladstone to discharge, thence to Singapore for repair.

No injury was sustained by any individual. No pollution resulted.


GULF OF PAPUA
Merauke
Shoalwater Pt
Saibai I
Dauan Is
Bligh Entce
Bramble Cay
Yule I
Portlock Reefs
TORRES STRAIT
10° S
Badu
Moa
(380)
(226)
(178)
(162)
AREA Of CASUALTY
Aero RC
Horn I
Booby I
Prince of Wales I
(232)
Carpentaria Sh
Cape York
C Grenville
Albatross B
Duyfken Pt
Aero RC
Weipa
Ashmore Reef
Eastern Fields
CORAL
GREAT BARRIER REEF
Second Three Mile Opening
Two Mile Opening
C Melville
C Flattery
Osprey Rf
Shark Rf
Cooktown
Aero RC
Cruiser Pass
Trinity Opening
Grafton Passage
Euston Rf
Cairns
Aero RC
Fitzroy I
Karumba
Aero RC
Normanton
QUEENSLAND
145° E
15°
7°E(2°E)
8°E(2°E)
ROUTE OF RIVER EMBLEY THROUGH NORTH QUEENSLAND WATERS
TRACK OF RIVER EMBLEY

AUTHORITY TO CONDUCT INVESTIGATION

On 11 May 1987 Christopher William Filor, Director, Ship Operations, of the Federal Department of Transport's Central Office, Canberra, was appointed under Section 377A of the Navigation Act 1912 to make a Preliminary Investigation into the circumstances of the grounding of the Australian Registered ship RIVER EMBLEY in the vicinity of Latitude 10 degrees 29 minutes South, Longitude 142 degrees 21 minutes East on 9th day of May 1987 and in particular

the factors which caused or contributed to the grounding

the actions taken by the Master and Crew to protect life, property and the environment after the grounding.

PERSONS INTERVIEWED AND SOURCES OF INFORMATION

The following crew members were interviewed on 19 and 20 May 1987 at Gladstone

Per Moen	Master	Certificate of Competency as Master of a Foreign Going Steam Ship
Charles Peter Stocking	Chief Mate	Certificate of Competency as Master of a Foreign Going Steam Ship
Mark Taxis	2nd Mate	Master Class 1
William Henry Hill	3rd Mate	Master Class 1
William James Donald English	Chief Engineer	Engineer Class 1 (Steam and Motor)
William John Metcalfe	2nd Engineer	Engineer Class 1 (Steam and Motor)
Robert George Walker	3rd Engineer	Engineer Class 1 (Steam Ship)

On 21 May 1987 at Sydney

John Ronald Snelgrove	Pilot	Queensland Coast and Torres Strait Pilotage Service, Certificate of Competency as Master of a Foreign Going Steam Ship

On 19 April 1988 at Gladstone

Geoffrey George Golik	Helmsman	Able Seaman

Discussion and correspondence were also undertaken with the Hydrographer RAN and his staff. Position checks and checks of water depth were initiated and undertaken on 27 May by HMAS BENDIGO with Commander R. Cotton RAN of the Hydrographer's staff aboard. The results were processed and telexed to the investigating officer on 5 June.

An independent assessment of the effects of shallow water and the phenomenon of squat was commissioned on 26 May from AMC Search Ltd, Launceston.

The records of proceedings of the Maritime Services Advisory Committee Navigational Safety, and the records of the Navigational Aids Branch of the Department of Transport were also extensively consulted.

The Department of Earth Sciences, Flinders University was consulted on tidal data.

The Australian Institute of Marine Science was approached for information on water density in Torres Strait.

The Meteorological Records Office provided data on weather conditions, at Thursday Island for the period 26 April to 9 May.

The Australian National Line management answered specific questions by correspondence and furnished other details relevant to the investigation.

PREAMBLE

The report is based on the documents and other material collected from the RIVER EMBLEY, from interviews, statements and the sources detailed on pages 4 and 5.

Background material used by the Investigating Officer relevant to the investigation is contained in the appendices to this report.

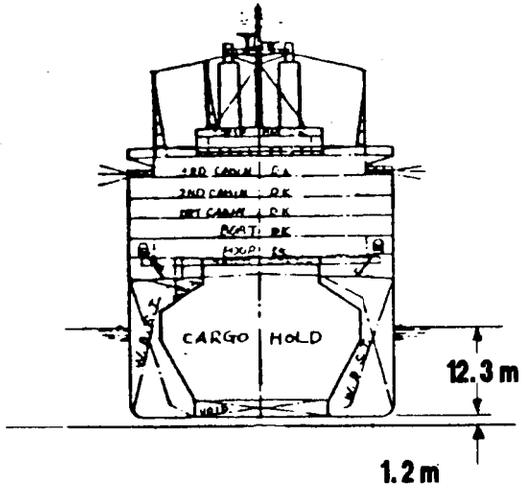
All times are given in Eastern Standard Time.

The units of measurement as stated in source documents are used in the report. Where these are quoted in Imperial Measurement' the Metric equivalent follows in parentheses. Distances are stated in nautical miles or cables* as appropriate.

* CABLE A nautical unit of measurement, 0.1 of a sea mile (185.lm).

RIVER EMBLEY

SCALE 1: 1000

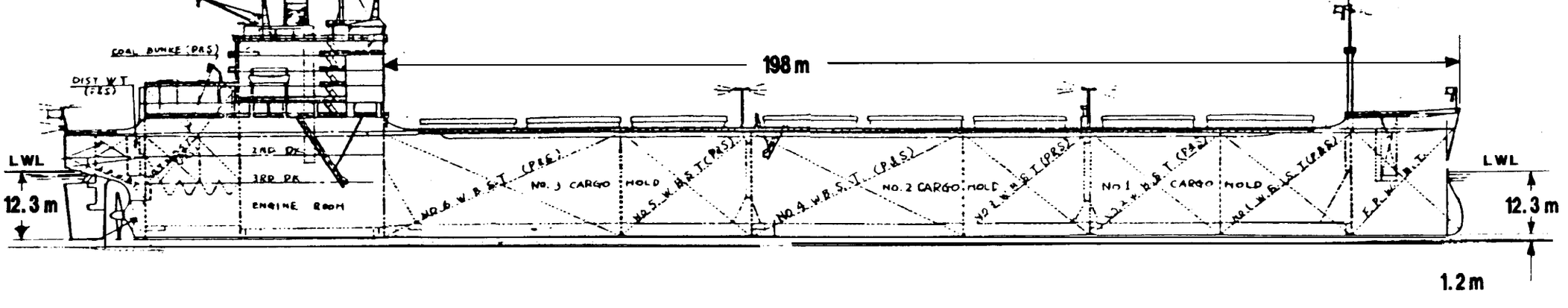


PRINCIPAL PARTICULARS

- CLASS:~ L R S

- PRINCIPAL DIMENSION:~

LENGTH (O.A)	255.00 M
LENGTH (B.P)	248.00 M
BREADTH (MLD)	35.35 M
DEPTH (MLD)	18.30 M
DRAUGHT (MLD) (DESIGN)	12.20 M
" (SUMMER)	12.30 M



THE SHIP

The Australian National Line ship RIVER EMBLEY is a bulk carrier on charter to the Queensland Alumina Company. It is 255 metres in length, with a beam of 35.5 metres, and has a capacity of 76305 tonnes of cargo, bunkers, water and stores at a maximum summer draught of 12.325 metres. Specific details of the vessel are at Attachment 6.

The vessel had current survey certificates in respect of Safety Construction, Safety Equipment, Radio and Load Line Certificates.

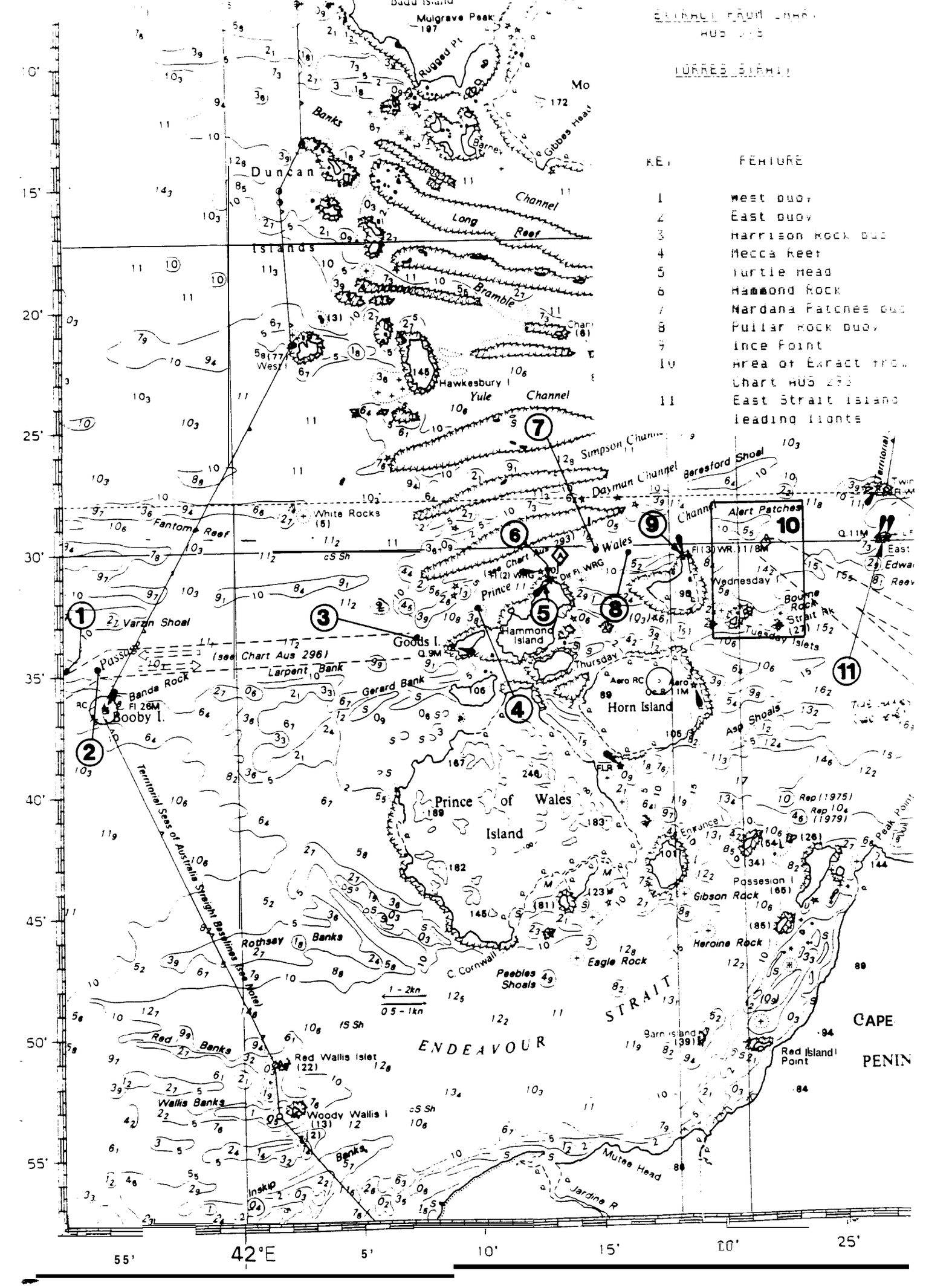
The vessel was equipped with modern navigational aids including a Tokyo Kerki Auto Pilot PR-500 and gyro, two Sperry Radars (1x3 cm, 1x10 cm), Furuno Doppler log, Simrad I.R 201 echo sounder and Decca 054 Satellite Navigator. All equipment was in proper working order.

The RIVER EMBLEY is propelled by steam turbine powered by coal-fired boilers. The ship was specifically designed for the route between Weipa on the Western side of the Cape York Peninsula and Gladstone, where the ship is able to take on sufficient coal bunkers for the round trip to Weipa.

NAVIGATION IN TORRES STRAIT

General

Torres Strait is that stretch of water between Cape York Peninsular and Papua New Guinea. The area is the site of islands and reefs and is generally shallow. Only one commercial route has been proved to date, via Gannet Passage and the Prince of Wales Channel, taking ships immediately north of Goods, Hammond and Wednesday Islands, into the inner route of the Great Barrier Reef or into the Coral Sea via the Great North East Channel. The route is an important commercial shipping route, saving some 600 miles over alternative routes between Singapore and Brisbane and some 2000 miles between Weipa and Gladstone. The size of ship using this route is restricted by draught by reason of the limited depth of water available.



KEY FEATURE

1 West buoy
2 East buoy
3 Harrison Rock buoy
4 Mecca Reef
5 Turtle Head
6 Hammond Rock
7 Nardana Patches buoy
8 Fuller Rock buoy
9 Ince Point
10 Area of Extract from Chart AUS 293
11 East Strait Island leading lights

Previous Casualties

The grounding of the RIVER EMBLEY is the fourth such incident to have occurred at the eastern extremity of Prince of Wales Channel since 1970.

The Liberian tanker OCEANIC GRANDEUR of 58062 deadweight tons grounded in Torres Strait on 3 March 1970 with a cargo of crude oil. The vessel was under pilotage and drawing 38ft 08in (11.783m). Substantial pollution resulted. The ship was found to have struck a rock pinnacle that was not charted. Subsequently the rock was located and a safe depth over the rock of 12 metres was achieved by blasting. This rock is now known as "O.G." rock.

On 18 August 1985 the Liberian cargo ship MARITIME GARDENIA grounded on Alert Patches. The ship was proceeding without a pilot at an approximate draught of 8 metres. The ship grounded on charted shallows. Human error of judgement in navigation was cited as the cause of the grounding. No pollution resulted.

On 24 July 1986 the Liberian Tanker MOBIL ENDEAVOUR grounded south of Alert Patches. The ship was proceeding to the Great North East Channel without a pilot and had a static draught of approximately 11.8 metres. The ship, navigating under the specific orders of the Master, left the port hand buoy to the starboard (south) side of the ship and grounded in an area known to have a minimum chart datum of 11 metres. The report on the incident concluded that the Master was responsible and his navigation was deficient. The ship's owners suspended the Master without pay for 6 months and the Liberian Authorities suspended his certificate for a similar period. No pollution resulted, largely because the tanker was of modern design having a double bottom, or skin. The Master's decision to pass to the North and the wrong side of Alert Patches buoy was the main cause of the grounding.

This casualty coincided with a discrepancy between the height of tide predicted and the broadcast height of tide at Ince Point. On 21 August 1986 the Hydrographer RAN checked and confirmed that the tide gauge was operating correctly and was based on the correct chart datum.

SEQUENCE OF EVENTS

On 3 May 1987 the RIVER EMBLEY sailed from Gladstone to Weipa in ballast, with 33 crew and a pilot of the Queensland Coast and Torres Strait Pilot Service.

The RIVER EMBLEY was commanded by Captain Per Moen. Captain Moen has served on ANL ships for twenty years and has held command for the last eight years. In that time he has undertaken many voyages through the inner route of the Great Barrier Reef. He had been in command of the RIVER EMBLEY for about one year at the time of the incident.

The Pilot, Captain John Snelgrove has 25 years sea service including three years in command and four years in ship management. He joined the Queensland Coast and Torres Strait Pilot Service in 1968. In the last two years he estimated that he had piloted 23 ships with a draught in excess of 11.3 metres, this number being approximately one quarter of his quota of ships for this period. In total he had piloted the RIVER EMBLEY on eleven round voyages, four at maximum draught. The Pilot had charge of the navigation between Gladstone and Booby Island at the western approaches to the Torres Strait.

The voyaqe throuqh the inner route of the Great Barrier Reef to Booby Island and thence to Weipa passed without incident.

The RIVER EMBLEY arrived at Weipa in the early hours of 8 May 1987. The Master and Pilot both stated that during the day in Weipa they discussed the east bound transit of the Gannet Passage and Prince of Wales Channel which together form the commercial shipping route through the Torres Strait. The Pilot produced a plan of this section of the voyage and this was approved by the Master. The Master stated that he made a voyage plan but did not record it in writing as he considered the Pilot's plan to be quite adequate and correct. The Pilot's plan consisted of details of times between the various way points on the transit., the underkeel clearance required, shown as 1.0 metres and 1.22 metres on the plan; minimum depth required, the minimum tidal parameters and total transit times (Attachment 4). The Master stated that an allowance of about 1 metre was made for squat at a speed of 10 knots. He also said he was aware that tables were available showing squat values, however as these tables were calculated for restricted water depths of 15 metres they were in his opinion irrelevant to the conditions under which his ship operated. It was stated by the Pilot that the option of anchoring, should there be insufficient water, was discussed and it was agreed that should it be necessary, the deep water anchorage west of Goods Island would be used. The plan made no reference to courses or alter course positions.

Loading in Weipa was completed at 2130 8 May 1987. An obstruction of the channel to Weipa restricted the loading of the RIVER EMBLEY to 61630 tonnes of bauxite, some 15,000 tonnes below full capacity. The vessel also carried 2556 tonnes of consumable coal bunkers, residual ash, fresh water and stores. An independent draught survey was undertaken to establish the quantity of bauxite shipped. A final draught of 10.97 metres forward and 11.09 metres aft, giving a mean draught of 11.04 metres, was established by the draught surveyor. These draught readings were recorded in water of density 1018.5. The Chief Mate (the Mate) stated that the ship's draught in normal salt water (1025) would be decreased by 0.07m (7 cm) making the draught 10.90m forward and 11.02m aft and a mean draught of 10.96m. The draught survey record sheet also

shows that the port midships draught exceeded the starboard midship draught by 0.04 metres (4 cm). This resultant list was not discernible with the naked eye and did not increase the draught to any significant degree.

An element of the draught survey was to sound all tank spaces. The survey confirmed that only minor residual water was left in ballast tanks and these were effectively empty.

The RIVER EMBLEY sailed from Weipa at 0248 hours 9 May. The ship cleared the fairway buoy by 0430 and according to the bridge log book set course at maximum engine revolutions for Booby Island, a distance of 151 miles.

The Ship's Tank Sounding book shows that tanks were sounded routinely at 0700 on the morning of 9 May. The ballast tanks and the void spaces dere shown as empty and in the same state as at the time of the draught survey. There is no indication that the state of these spaces changed at any time prior to the grounding.

Records show that from 0800 hrs on 9 May, the transmissions from the broadcasting tide gauge at Booby Island were monitored every half hour until 1430. (Attachment 5).

During the morning the Mate was engaged in repairing number 2 cargo hatch, and the Master, recognising the extended hours of duty undertaken by the Mate during loading, undertook to keep the 1600-2000 hour watch later that day, a practice stated to be normal under the circumstances of the ship's schedule.

At 1418 the engine room telegraph movement recorder shows a movement of "stand by". This would have reduced the engine revolutions. Control of the main engine was thereafter under the control of bridge personnel. Major alterations in engine revolutions could be made by moving the telegraph setting, small alterations by using a control knob mounted on the telegraph handle.

A little before 1430 the Pilot, Captain Snelgrove, assumed charge of the navigation with the 2nd Mate as officer of the watch. The automatic steering was disengaged and the ship was put into hand steering. The deck log book entry records that at 1430 the ship passed the Western buoy at the entrance to Gannet Passage at a speed stated by the Master to be about 6 knots. At this time the predicted and actual tide gauge readings broadcast from Ince Point were also recorded and showed a reading 0.39m below predicted height. Ince Point tidal readings had been identified on the passage plan as providing the critical datum for depths in the area of Nardana Patches and the Pullar Rock. According to predictions in the Australian National Tide Tables the tidal stream was running in an Easterly direction. At 1443 the ship passed the East buoy and the ship, steering 088°(T) was again put on automatic steering, with the stand-by helmsman readily available. Between East Gannet buoy and Harrison Rock the ship made good a speed of 11.82 knots with telegraph on 'Stand-by . At 1500 the Ince Point tide gauge was broadcasting 0.42 metres below predicted height. The Thursday Island weather report for this time was of an easterly breeze at eleven knots, barometric pressure 1010.0 and falling, with 16 miles visibility.

At 1550 with Harrison Rock buoy abeam the ship's position was entered in the deck log book and on the chart and passage commenced through the Prince Of Wales Channel. The ship was again placed in hand steering and course altered

to 055°(T). At 1600 the helmsman was relieved, the Master relieved the 2nd Mate and assumed the duties of the Officer of the watch. The engine revolutions were reduced to 47 rpm approximately. The conditions noted in the deck log book were of cloudy, fine and clear weather, barometric pressure was 1009.5mb, wind NE'ly 3. The reading on the ship's log was entered as '172'.The broadcast height of tide at Ince Point was 0.4 metre, 0.47 below the predicted height of 0.87m.

In compiling his voyage plan the Pilot tabulated the minimum depth he required for the transit as being 12.0 metres in Gannet Passage and 12.22 metres in Prince of Wales Channel. These depths made allowance for under keel clearance of 1 metre in Gannet Passage and 1.22 metres in Prince of Wales Channel based on a maximum draught of 11.0 metres as advised by the Master. The predicted and broadcast height for Booby Island tide gauge was 2.5 metres, 0.6 metres above the minimum required under his plan. No record was made of the broadcast height of tide at either Goods Island or Turtle Head tide gauges, but based on predicted heights there was between 0.64 and 0.58 of a metre of water more than the minimum.

The Ince Point Tide Gauge was broadcasting a height of 0.4m above datum, just .08m (8 cm) above the minimum required and some 0.47 metres below predicted height of 0.87m. During the period 1550 to 1620 the maximum effect of the east going tidal stream would have been experienced.

At 1607 the ship began to shape a course of 097°(T) and, according to the deck log book, passed Hammond Rock to starboard at 1612 at a distance of 0.4 miles (4 cables). The time of passing the buoy was recorded in the deck log book and on the chart. At approximately 1618 the telegraph recorder roll shows a movement of full ahead as being rung on the telegraph and at about this time the ship commenced an alteration of some 25° to a course of 072°(T). At 1622 the ship passed Nardana Patches buoy at 0.2 miles (2 cables) which again was recorded in the deck log book and on the chart.

At 1629 the speed was increased to navigation full ahead and the Master stated that at about 1630 he rang the engine room to inform them that the ship would be passing Ince Point, the position used for ringing "full away", at 1642, and that the programme for increasing the ship's speed could be commenced. The ringing of "full away" signified that the ship was clear of the significant constraints of the Prince of Wales Channel and had entered the less restricted passage of the Inner Route where constant need for engine movements were not anticipated. The tide gauge reading broadcast from Ince Point remained at 0.4 metres (0.4m approx below the predicted height for this time. Low water at Ince Point as predicted by the Australian National Tide Tables was at 1630 at a height of 0.8m). No further tide gauge readings were recorded on board. The tidal flow was minimal. At about 1631 the RIVER EMBLEY started to alter to 090°(T) to bring the ship onto East Strait Island leading lights and the vessel settled on course at about 1635.

At 1642 the Master fixed the ship's position on the chart with Ince Point Lt 178" x 0.6 miles and entered the position and log reading of '180' in the deck log book. Both the Master and the Pilot stated that the vessel was just south of the East Strait Island leading lights. The Master stated that he forgot to ring 'full away' at this point despite a specific note inked on the chart that the engine room should be advised (Attachment 3). The ship's engine revolutions were at this time being increased slowly from 55 rpm. The weather remained fine and clear with an easterly breeze of force 3-4.

The RIVER EMBLEY would have cleared O.G. Rock, some 2 miles or 10 minutes beyond Ince Point. O.G. Rock in position 10° 29.95' South 142°20.68' East has a chart datum of 12 metres and lies 0.1 miles (1 cable) south of the line of the East Strait Island leading lights. Relatively deep draught ships must bass north of this obstruction before openinq the leads to the south to clear the shoal area close north of the line of the leading lights 0.33 of a mile (3.3 cables) beyond O.G. Rock (Attachment 1).

Between 1418 and 1645 hours the Chief Engineer and 3rd Engineer were in the engine room whilst the ship was in stand by condition. The Chief Engineer stated that at 1642 all the necessary readings had been taken for the ANL performance log, in anticipation of 'full away' being rung as advised by the Master at 1630. He stated the main engine was turning approximately 55 rpm and the ship's log recorder showed a speed of 12 knots. The Chief Engineer left the engine room at 1645. The Chief Engineer further estimated that by 1656 the engine would be turning 60 rpm.

A little before 1654 the 3rd Engineer had phoned the bridge and reminded the Master that full away had not been rung at 1642. This was then done and the engine movement print out records full away at 1654.5. The Master stated that he then fixed the ship's position with a bearing from East Strait Island leads and a distance from Ince Point. This position was marked from Alert Patches buoy. The Master moved from the chart table to the engine room telegraphs just to port of the centre line. The Pilot was just to starboard of the steering console, both maintained that the ship had set slightly to the south of the leading lights. The helmsman however maintained that, without the use of binoculars, the leading lights appeared to be in line.

During the watch both the Pilot and Master stated that they engaged in conversation, mostly inconsequential, remarking upon the good weather and visibility conditions they enjoyed. Both men stated that their conversation did not distract them from their duties.

At approximately 1656 the Master, Pilot and Helmsman felt the ship shudder. The Master described two such sensations a few seconds apart while the helmsman recalled that he had no doubt that the ship had touched bottom. The Pilot stated that he did not immediately associate the shudder with contact with the sea floor, but took it to be the action of the sea of the side of the ship and regarded it as not unusual. At this time or immediately after the Pilot ordered an alternation of course to 120°(T). Both the Master and Pilot maintained that the ship was marginally south of the East Strait Island leading the lights, while the helmsman's recollection was that, to the naked eye, the lights were in line. The Master estimated the ship's speed at this time to be 10.4 knots.

The contact was felt elsewhere in the ship. The Mate, 2nd Mate, Chief Engineer and 2nd Engineer were in the Officer's smokeroom. They variously described a sensation of one or two distinct bumps. The officers went to the games room to look aft at the ship's wake for any mud disturbed from the sea bed but could not see any. The Mate stated that he saw a buoy just forward of the beam on the starboard side and this was later established as Herald Patches buoy. He looked at his watch which read 1657. The 3rd Mate stated that he was in his cabin and felt a bump at approximately 1655.

After 'full away' was rung at 1654.5 the 3rd Engineer, on duty in the Engine

Room left the Engine Room Control room to carry out maintenance work in the machinery spaces. He was on the 'stoker flat' when the Master phoned to enquire whether he had felt a "bump" The 3rd Engineer stated that he had not.

There were no ships in the immediate vicinity of the eastern approaches to the Prince of Wales Channel at the time of the incident to restrict the RIVER EMBLEY'S passage.

AFTER THE GROUNDING

The statements made by the various personnel as they refer to the time immediately after 1656 differ slightly but the following sequence of events would appear to be substantially accurate.

Almost immediately after 1656 the 3rd Mate went to the bridge. He confirmed that he had felt the ship bump a few moments before. The Master instructed the 3rd Mate to assist the Pilot and asked the Pilot to take the vessel to a safe anchorage. The Master left the bridge and went to the officers smokeroom where he spoke with the Chief Engineer. Both the Chief Engineer and 2nd Mate expressed an opinion that the ship had trimmed by the head. The Chief Engineer left to check the engine room and steering machinery. The Second Engineer had preceded him and the watertight integrity of the engine room was checked. The Master returned to the bridge.

The Mate went straight to the bridge and he stated he noticed that the ship appeared to be trimming by the head. He compared the forward and after echo sounder readings and confirmed that the forward transducer showed four metres less water under the keel than the after transducer. He stated that he went directly to the Ballast Control room where he activated the ballast control board and tank pneumercator. He noted that the fore peak tank pneumercator was indicating 4000 cu metres and all other readings were shown to be at "zero". This information was passed to the bridge. The Mate was joined by the 2nd Mate and the ballast pumps were brought into use to attempt to pump the water from the forepeak.

On receiving the Mate's report at about 1703 that the fore peak had 4,000 cu metres of water the speed of the ship was progressively reduced. At this time the Master made a public address announcement to the crew, calling all hands to emergency stations whilst assuring them that there was no immediate danger. The ship's position was fixed at 1710 as 094°(T)x4.73 miles from Ince Point light. At 1718 a message was passed via Thursday Island Radio to the Federal Sea Safety and Surveillance Centre stating that the RIVER EMBLEY touched bottom at 0658 GMT (1658 Eastern Standard Time) in position 10° 29.86'S 142° 21.11'E in the vicinity of Alert Patches Buoy, Prince of Wales Channel, Torres Strait. A similar message was sent to the Australian National Line.

The vessel anchored at 1726 with East Strait Island Light Beacon bearing 066°(T) by 2.6m.

The ballast pumps were unable to reduce the level of water to the forepeak tank. The Mate went to check the void spaces forward as these could not be monitored from the control room. It was established that number 1 void space was also taking water, but other spaces appeared dry. The Master considered that the ship was in no immediate danger. The depth of water around the ship

was checked to ensure the ship would remain safely afloat.

It was later established that number 1 and number 2 port ballast tanks had also been breached, but the inflow of water was relatively minor and the ship's ballast pumps were able to control it. The situation stabilised with the ship floating at a forward draught of 14.8 metres and an after draught of 9.52 metres. All soundings and tank spaces were frequently monitored to ensure that the ship remained in a safe condition.

Representatives of the owners and salvage experts boarded the ship after noon on Sunday 10 May. On the 11, 12 and 13 May divers using video equipment confirmed that the forepeak and number one void space had been damaged. Three separate parallel splits in the hull varying from 10 to 14 metres in length and between 40mm and 200mm in width were reported aligned fore and aft. The damage extended athwartships about 11 metres. The inboard split was found to be close to the line of the keel on the starboard side and the outboard split 9 metres from the keel on the port side. The latter damage extended into number 1 and 2 port ballast tanks.

It was decided that external repairs were not practical owing to the extent of the damage and the limited time that divers could work in the strong tides of the area. All openings to the spaces were sealed and the spaces pressurised with compressed air using ship's equipment. Spare compressors were available from ashore, but were not needed.

By 2000 hours on 13 May the ship's draught had been reduced to 11.4 metres forward and 11.2 metres aft. The ship remained at anchor while the Master, salvage operators, company officials and classification society surveyors satisfied themselves that the pressurised spaces could maintain the air pressure.

At noon on 14 May all parties were satisfied that the ship could proceed safely to Gladstone. The classification society gave conditional approval for the ship to resume the voyage and the vessel sailed for Gladstone under the command of the Master, with Captain Snelgrove as Pilot in charge of the navigation.

All bunker ash, ship rubbish and garbage was retained on board. No pollution occurred as a result of the grounding nor from the subsequent operations.

The RIVER EMBLEY arrived at Gladstone in the early afternoon of 18 May 1987. The Preliminary Investigation commenced at Gladstone on 18 May.

On 26 May AMC Search Ltd of Launceston was commissioned by the Federal Department of Transport to undertake a preliminary analysis of the effect of shallow water upon a ship of the RIVER EMBLEY'S size and draught in open sea conditions by estimating the sinkage anticipated based on existing vessels of similar form. Based on work by I.W. Dand, the report concludes that such a ship drawing 10.94 metres at a speed of 12.2 knots could ground in 13 metres of water. (Appendix 3)

On 27 May the patrol boat HMAS BENDIGO with a Commander of the Hydrographic Service RAN aboard, undertook a check on the position of Alert Patches Buoy and also took check soundings in the area where the RIVER EMBLEY was believed to have touched bottom. Alert Patches buoy was found to be 120 metres north of the charted position of 10° 29.8'5 142° 142° 21.06'E.

Check soundings were also taken which defined the southern extreme of the rock outcrop of Alert Patches at a depth of 12.5 metres (+/- 0.4m) below chart datum. The outcrop extends approximately 50 metres south of the line of the East Strait leading lights and indicated no change in charted depth from the HMAS FLINDERS survey of 1974/76.

The possibility of changes in water density in the area, through the outflow of the Fly River, was canvassed with the Australian Institute of Maritime Studies. The advice received was that it was improbable that water density at Alert Patches would be affected. This was supported by density samples taken by the staff of the lighthouse tender Cape Moreton in June, which recorded densities in the general area of Torres Strait as 1025 or slightly more.

OBSERVATIONS

There would appear to be a number of possible explanations for the grounding of the RIVER EMBLEY

the Pilot and Master were mistaken in their position relative to the East Strait Island leading lights and were north of the leading line and in an area of shoal water

the ship's maximum static draught was greater than ll.Om at the time of grounding

an area of unknown shoal water, or isolated bommies exist that have not been detected by hydrographic survey, and/or the chart is otherwise inaccurate

the general sea level was below the 'normal sea level

insufficient allowance was made for underkeel clearance, or in some other way the passage plan mutually agreed by the Pilot and master was deficient

a combination of two or more of these factors.

From statements made by those interviewed and from information contained in bar records and accounts there is no evidence that either Captain Moen or Captain Snelgrove were unfit to undertake their duties.

Ships Position

The time and position of alteration on to East Strait Island lead lights at about 1632 was not noted on the chart or in the deck log book. The accuracy of the positions throughout the passage are hard to assess from examination of the ship's chart. Under pilotage it is common practice for such positions to indicate the time of passing relevant features, rather than fixing the position more accurately.

The 1655 position was stated by the Master to have been taken as a bearing from East Strait Island leading lights and a distance from Ince point (Attachment 3). The position however was entered in the deck log book as Alert Patches buoy 026° x 0.15'. A bearing and distance from the buoy as recorded in the log book, with the buoy 120 metres north of its charted position as reported by HMAS BENDIGO, would have put the ship north of the line of the East Strait Island leading lights. Both the Master and Pilot were adamant that the East Strait Island leading lights were open and the ship was to the south of the line; while the helmsman's recollection, when interviewed in April 1988, was that to the naked eye the lights were in line. The pilot stated that the lights were in line at 1635 and that by 1642 a southerly set had placed the ship south of the leads. Apart from the entry in the deck log book there is no evidence that the ship was north of the line of the leading lights.

While it may be accepted that the ship was on or marginally south of the leading line, the easterly component of the position of grounding is uncertain. It is important to consider the time taken to travel one ship's length and the distance from the bridge to the bow. The ship travelling at

12 knots covers 370.6 metres per minute or one ship's length of 255 metres in 42 seconds. The bow is 195 metres from the bridge, a relative time of 32 seconds. In confined waters such considerations are important factors in altering course and remaining in navigable water.

It is not possible to determine absolutely whether the order to alter course from 090°(T) was given before or after the ship grounded. The Pilot maintained that the order to alter was made before and this is consistent with the Master's statement and recollection at interview. The helmsman in a written statement made on 10 May 1987, the day after the grounding, stated the order was given after he felt the ship ground.

Ship's Speed

The Master estimated the ship's speed at 10.4 knots at the time of the grounding. This estimate coincides with the distance recorded on the chart between 1642 and 1655. However, the Chief Engineer's observations of the ship's speed and revolutions turned at 1642 are consistent with the speeds calculated from the ship's log, course recorder and charted positions from the time of entering Gannet Passage. The distance from the entrance to Gannet Passage to Alert Patches is 29 miles. The ship would require a speed of 12 knots to cover this distance in the 2 hours 25 minutes recorded. The transit of Gannet Passage was completed at an average speed of 11.55 knots and the 13.8 miles from Harrison Rock to the 1655 position gives a speed of 12.55 knots. Similarly the distance between 1622 and the position at 1710, taken by the 3rd Officer is 9.23 miles giving an average speed of 11.5 knots in a period when the revolutions were rapidly decreased from 1703.

These speeds are based on distance recorded over the ground. The speed through the water, however, would have been less due to the east going tidal stream. This stream would have been weak in Gannet Passage at a maximum between 1550 and 1620. Thereafter the effect would decrease on a slackening rate in the relatively more open water. The Pilot assessed the effect as negligible at 1700 hours. While, however, the effect of the tidal stream diminished the ship's speed was progressively increased from about 1629 when "NAV F-Ahd" was rung and the vessel cleared the area considered by the Pilot to be critical to underkeel clearance.

Ships Drauqht

The ship sailed from Weipa with a draught corrected for a salt water density (1025 SG) of 10.9m Forward and 11.02m Aft. This draught was confirmed by an independent draught survey.

The Mate estimated the draught at the time of grounding as 10.95 metres forward and 10.89 metres aft assuming normal sea water density. Check calculations allowing for 105 tonnes (net 95 tonnes allowing for ash residue) being consumed 104 metres aft of midships and 25 tonnes of fresh water being consumed 118.65 metres aft of midships suggests this estimation to be substantially correct and that the ship was probably trimmed marginally by the head. (Check calculations give 10.97m forward and 10.91m aft).

There is no evidence to suggest that anything happened nor that any operation was undertaken which would have increased the RIVER EMBLEY'S static draught between departure Weipa on 9 May and the time of the grounding. The tank sounding book entry of 0700 9 May 1987 shows that all ballast tanks and void

spaces were effectively empty.

Chart Information

The charted depths in Torres Strait have been subject to extensive survey. The international standard of accuracy for soundings in waters of the 0 to 30 metre range is 20.3 metres. While much of the Torres Strait area is charted to this accuracy, the Hydrographer in letters to the Marine Board of Queensland dated 23 April 1981 and 16 April 1987 stated that errors in charted depths may be as much as 0.5 metres. Additionally Chart Aus 293 carries a note below the title:

CAUTION - SAND WAVES

> Herald and Alert Patches are sand wave formations which cause variations in charted depths. The sand waves trend S.E. from Herald Patches and N.E. from Alert Patches. In addition, rocky outcrops occur in the channel between the patches.

Surveys in 1971, 1974, 1976 and subsequently May 1987 show shoal water to the north of the line of the East Strait Island Leading lights with soundings of 11 and 12 metres. Depths to the south of the leads were found to be 13 metres or more, though close south of the line intermediate depths were found. The spaces between the lines of soundings were 30 metres or less.

Tidal Information

Predicted times of low water for the tide gauges in Gannet Passage and Prince of Wales Channel are taken from the Australian National Tide Tables and hourly predictions taken from the Torres Strait Tide Tables, published by the Department of Transport. It should be noted that the Torres Strait Tables do not necessarily indicate the lowest water available. The predictions for 9 May 1987 are as follows.

	National T.T. Low Water		Torres T.T. Low Water		Critical Depths	
Port"	Time	Ht m.	Time	Ht m.	Area	Datum
Booby Is	1817	1.3	1900	1.52	Gannet Ent	10.1
Goods Is	1822	1.5	1800	1.48	Sund Rf	11.2
Turle Hd	1727	1:o	1700	1.01	Pullar Rk	11.6
Inc Pt*	1630	0.9	1700	0.76	O.G. Rock	11.9
Twin Is**	1633	0.6	1700	0.62		

* Standard Port...Thursday Is.
** No broadcasting tide gauge.

The broadcasting tide gauges also record tidal information hourly. The record is maintained on battery backed random access memory cards. Information from these cards is transferred to a computer in the Department of Transport and Communications. The Booby Island records are supplemented by a pen and ink trace.

When the tidal information from Ince Point was examined it was found that the recorder had malfunctioned and the data was corrupted, it was therefore important to establish the reliability of broadcast data from Ince Point.

CSS06D0423

These records and weather data for the preceding fortnight were sent to Professor G.W. Lennon of the School of Earth Sciences, Flinders University for a preliminary study.

Professor Lennon drew attention to the International Sea Level Pilot Project based in Hawaii. A report of sea levels for the month of May in Torres Strait area indicated that levels were 0.15m to 0.20m below normal levels.

Further the School of Earth Sciences reported that over the critical hours of 1600 and 1700 the heights of actual tide at

> Booby Island was within reasonable tolerance of the predicted height to be considered accurate
>
> Goods Island was in excess of predicted height
>
> Turtle Head was 0.3m below predicted height

From this information it would appear reasonable to assume that the Ince Point Tide gauge was broadcasting correctly and the water depth was 0.5m below that predicted.

Based on these figures and the relative closeness of Ince Point to Twin Island it may be assumed that the height of tide at Twin Island was also in the region of 0.5m below predicted height and that the actual height of tide at Alert Patches can be extrapolated on a linear basis between the two stations. It may therefore be assumed that the depth of water at Alert Patches was in the region of 0.3m above datum, making a depth at the 13.5m datum south of the East Strait Island leading lights of 13.8m (Attachment 1).

Under Keel Clearance

The Pilot's passage plan (Attachment 4) consisted of times between the various way points, the minimum depth required at any part of the passage, the minimum rise of tide required and the tidal 'window' for the transit on 9 May. The plan shows that, allowing an underkeel clearance of 1 metre based on static draught, the passage of the Western entrance to Gannet Passage had to be completed by 1630 hours or the ship would have been delayed until 2100 hours that night. The plan also shows that the minimum under keel clearance was calculated on a static draught making an allowance of 1.22 metres for the transit of the Prince of Wales Channel. It should be noted that the preamble to the Torres Strait Tide Tables under 'Pilotage service advice' states:

> "2. The pilot service will accept vessels for pilotage with draughts not exceeding 12.2 metres provided that an underkeel clearance of at least 1 metre is maintained in Gannet Passage. Depending on weather and sea conditions the underkeel clearance may be increased at the pilot's discretion. In Prince of Wales Channel, 1 metre underkeel clearance will be maintained in vessels with draughts up to 11.89 metres, thereafter 10 per cent of the draught up to draughts of 12.2 metres. Tidal heights may differ from predicted heights owing to meteorological and other factors."

The requirement to maintain the respective underkeel clearance at all times is established Department of Transport and Communications policy and is well documented.

The Queensland Coast and Torres Strait Pilot Service, while being aware of the Department's policy, apparently regard such guidelines as not being in keeping with international practice of using static underkeel clearances nor that of the Department of Harbours and Marine, Queensland, for all their ports. In discussions with the pilots it was stated that they maintain a safe underkeel clearance having regard to all external factors (tidal conditions, weather, movement and the like) by careful control of the ship's speed.

The word "maintained" is therefore not used in the Annual Notice to Mariners Number 23, Queensland Coast and Torres Strait Pilot service - Draught Limitation and Advice, issued under the authority of the Department of Harbours and Marine and the Pilot Service. (See Appendix I).
The various factors that have an effect on under keel clearance are referred to in the Torres Strait Tide Tables.

> "When planning for the voyage, account should be taken of a number of uncertainties or inaccuracies which, if cumulative, could have a considerable effect on the underkeel clearance. These may occur in:
>
> (a) ship's draught as a result of movement in a seaway
> (b) ship's draught as read or calculated
> (c) tidal predictions
> (d) charted depths
> (e) the calculation of squat
> (f) the height of the sea level, through varying meteorological conditions."

With reference to the above factors;

(a) It was stated by the Master and Pilot that the sea was calm and that no pitch or roll was observed. It should be noted, however, given the ratio of the depth of water to the length and breadth of the ship the slightest movement would affect the underkeel clearance and a pitch of 0.325 of a degree as measured from the bridge front would cause the bow to sink 1.2 metres. (See scale drawing page 6)

(b) A maximum draught of 11.00 metres was used as the basis for this transit. It is probable that the deepest static draught was 10.97 metres, being the forward draught. It is therefore accepted that the actual draught was marginally less than the 11 metres static draught used by the pilot.

(c) The tidal predictions contained in the Torres Strait tide tables are stated to be correct to within 0.2 metres allowing for normal meteorological conditions. The predictions were compared to the actual height as broadcast by the tide gauges. (See "Tidal Information", page 20).

(d) Chart AUS 293 indicates a 10.8 metre "less water reported" close north of the line of the East Strait Island leading lights and depths of 13.6 metres to the south of the line. The intermediate depth of 12.5 metres as surveyed by HMAS FLINDERS and confirmed by HMAS BENDIGO is not shown. Chart AUS 293 is produced to a scale of 1:37,500 while the survey sheets are drawn to 1:2,500. From the chart information it would be reasonable to assume a progressive deepening between the 10.8 metres and 13.6 metres.

(e) Squat is a function of the ship's displacement, length, beam, draught, water density and of ships speed through the water. Expert opinion as to the extent of squat or sinkage in the water differs. There are two operating situations where squat is critical, these are:

i) in an enclosed channel and;

ii) in the open sea but with limited underkeel clearance; as experienced by the RIVER EMBLEY.

The RIVER EMBLEY has a block co-efficient of 0.846. The variable and critical factor was that of speed. (See "Ships' Position" page 18) A further factor in the phenomenon of squat is that of the actual underkeel clearance. This is expressed as a ratio of water depth to draught (H/T).

It is apparent that while an allowance for under keel clearance of 1.22 metres was made for passage through the Prince of Wales Channel, the effect of increased speed on the ship's squat was not calculated.

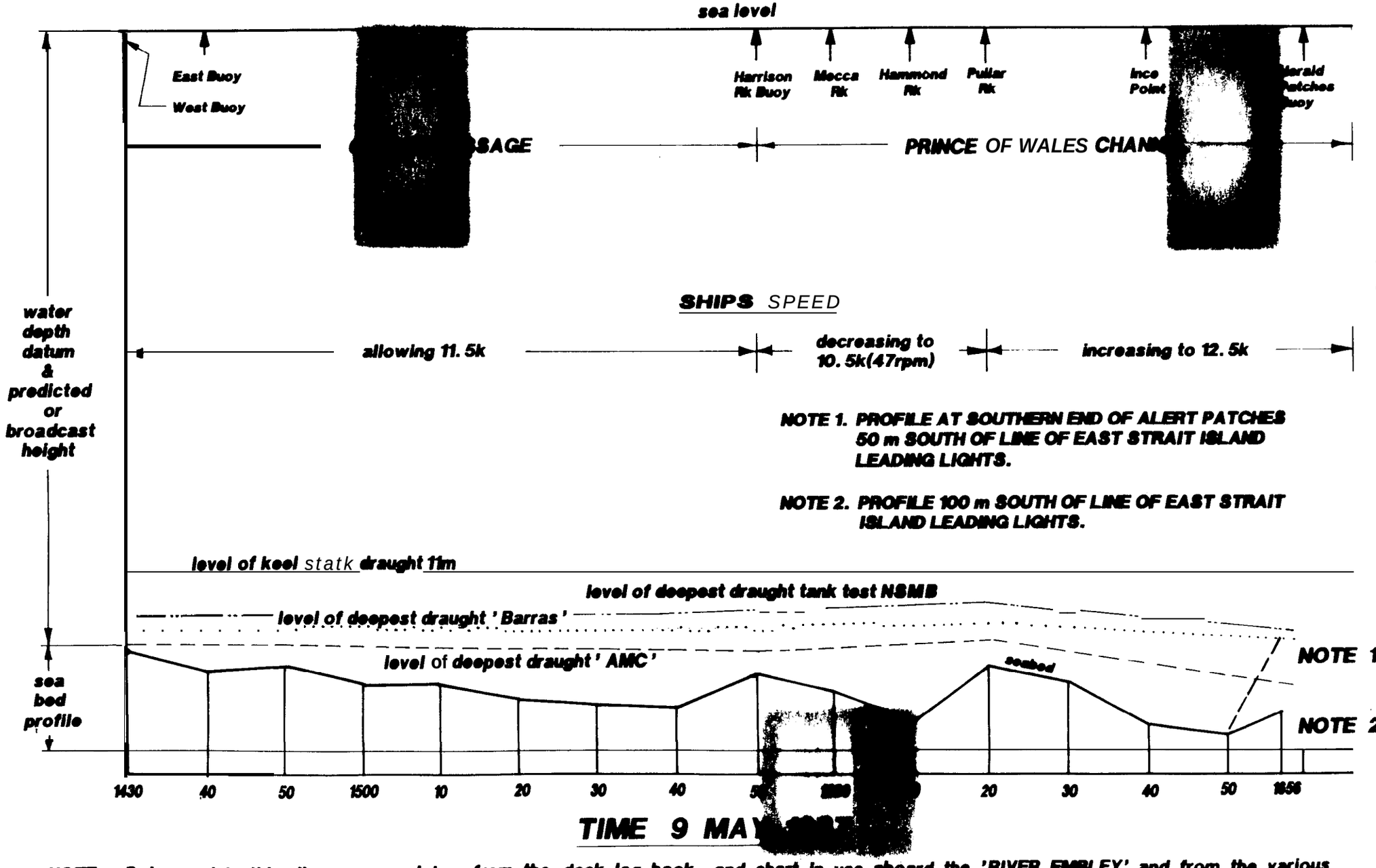
Passing reference is made to squat in the "Australian National Line Navigation and Bridge Organisation Manual, Voyage Planning 5.1(g). There is no mention of the phenomenon of squat in the Company's Operating Manual and there is no advice on the calculation of squat. The Master stated that there are no specific Company instructions and that he made an allowance of approximately 1 metre for a speed of 10 knots. The Company had, however issued the ship with details, including 'sinkage' tables, of a series of shallow water tests, completed in June 1981, by the Netherlands Ship Model Basin, Wagenngen (Appendix 3). These tests included the effects of squat of varying speeds at a draught of 12.2 metres.

The minimum depth of water simulated in these tests was 15 metres giving a static underkeel clearance of 2.8 metres. In scale propulsion tests the maximum sinkage forward at 10.4 knots was 0.8 metres and at 12 knots 1 metre, giving H/T as 1.15 and 1.13 respectively.

The ship grounded in an area where water depths are recorded as approximately 13.5 metres giving a static under keel clearance of 2.6 metres. This is a similar relative clearance as used in the tank test for the ship at 12.2 metres draught in 15 metres of water. The H/T factor is similar in both instances and it would have been reasonable to use the tables at least where the charted depth is 13.6 metres or more. The Master's stated reservation regarding the use of the tables appears to be based on the fact that for much of the Gannet Passage and Prince of Wales Channel the clearance is significantly less than 2.6 metres.

A formula that may be used in such open water situations has been developed by Professor C.B. Barras for ships with limited under keel clearance. According to this formula, for a ship of block co-efficient 0.846, a speed of 10.4 knots would have the effect of increasing the forward draught by 0.92 metres to a calculated draught of 11.89 metres. At 12 knots the draught would be increased by 1.22 metres to a calculated draught of 12.19 metres.

SEABED **PROFILE – TORRES STRAIT –** BASED ON SCALE OF TIME



NOTE : Data used in this diagram was taken from the deck log book , and chart in use aboard the 'RIVER EMBLEY' and from the various

AMC Search Ltd was commissioned to undertake a preliminary study of the phenomenon of squat as it might affect the RIVER EMBLEY in areas of reduced depth of water under the following terms:

> "Estimate sinkage anticipated based on existing data for similar formed vessels over range of depth/draft ratios and speeds at estimated load condition."

The report (contained in Appendix 3) shows that the estimated speed to cause grounding in 12.5 metres of water is 11.2 knots and in 13 metres of water is 12.2 knots.

Of the three methods considered in this report the tank tests on scale models must be preferred. Both the Barras and Dand methods are calculated for general categories of a ship rather than one specific hull form. It must be recognised however that both the tank test results and the Barras formula do not take into account the interaction of the sea bed when the water depth is less than H/T - 1.10. The effect of an irregular sea bed is also not addressed in these methods. The question is also raised as to why the ship did not ground earlier in the shallower water of the Gannet Passage or Prince of Wales Channel. The diagram of sea bed profile illustrates the theoretical clearance based on Barras, Dand and the Netherland Ship Model Basin.

(f) The Meteorological conditions at Thursday Island were not those associated with producing a negative tidal surge as outlined in the preface to the Torres Strait Tide Tables (Appendix 7).

The Australian Pilot Volume 111 publishes a climatic table for Thursday Island based on observations of between 15 and 50 years. For the month of May:

Pressure at Mean sea level mb	Wind Direction Percentage Frequency 7									Mean Wind Speed (Knots)
	N	NE	E	SE	S	SW	N	NW	CALM	
1010	1	1	14	80	3	0.5	0	0	0.5	8.5

Details of weather observations from Thursday Island supplied by the Meterological Office for the 26 April to 9 May 1987 inclusive and involving 59 observations at set times in the-day show an average pressure of lOll.3mb, wind from between 11°(T) and 150°(T) (98% of all observations), and a mean wind speed for the period of 15 knots.

The weather conditions during the fourteen day period therefore were apparently not those that would give rise to a significant effect on the predicted tidal data.

Passage Plan

The Australian National Line "Navigation and Bridge Organisation Manual" under 5. "General Instructions 5.1" gives guidance on passage planning. As stated earlier the Master accepted the Pilot's voyage plan as adequate and, in his opinion, this was in accordance with company requirements. It should be noted, however, that the wheel over, or course alteration positions, appear to have been left to the pilot and the ship's staff would have had only a general knowledge of optimum alter course positions and course to be steered. The

Pilot was navigating by land marks and the Master stated that he (the Master) did not know what these were. Thus when the ship cleared O.G. rock the Master could only check the position by visual or radar bearing. No visual position check was made until the ship was 2.2 cables clear of 0.G rock.

The voyage plan was not fully in accordance with detailed recommendations in the Australian Annual Summary of Notices to Mariners No.22 and there is every indication that the conning and conduct of the ship was, for all practical considerations, left solely in the Pilot's hands.

At interview Captain Snelgrove stated that prior to November 1986, when Alert Patches buoy was positioned south of its present position, close south of the line of the East Strait Island leading lights, it was his practice to alter course to the South some 3 or 4 cables from the buoy. This position coincides with the bridge of a ship being abeam of O.G. Rock. He went on to state that the buoy was only a guide and other marks, the East Strait Island leads and Tuesday Islet No 1, as clearing marks*, were available. Alert Patches buoy was altered in character and repositioned in November 1986, from position 10°29.9'S 142°21.O'E to 10°29.80'S 142°21.06'E (see Appendix 6). Prior to November 1986 the buoy, in its former position, would have obstructed the fairway in the vicinity of where the grounding took place, and ships would have been effectively forced south of this area.

Chart Corrections

The chart in use, AUS 293, was properly corrected to date. The "Less Water Reported" close north of the leading line (Corr 86/539), the general direction of buoyage for the chart, the amendment to the East Strait leading line (Corr 86/539), and the establishment of the isolated danger buoy together with the withdrawal of the port hand buoy (Corr 86/633) were all satisfactorily completed. It should be noted however that in amending the East Strait leading line by extending the pecked portion of the line to west of O.G. rock there is no practical differentiation between a leading line marking lights in line and a "recommended track not defined by fixed marks", as defined by "Symbols and Abbreviations used on Admiralty Charts", p21.

Ingress of Water

The rapidity with which the forepeak filled appears consistent with the dimensions of the breaches in the hull.

* CLEARING MARKS Two or more navigation marks or land features in juxtaposition that indicate that a vessel is clear of a danger.

CONCLUSION

I find that:

1. The RIVER EMBLEY touched bottom on the southern extreme of the rock outcrop of Alert Patches in a water depth of approximately 12.8m (12.5m sounding + tide height). The ship was approximately 90 metres south of known shoal water of 10.8 m marginally south of the line of the East Strait Island leading lights in approximate latitude 10 degrees 29.88 minutes South and between longitude co-ordinates 142 degrees 21.07 minutes East and 142 degrees 21.35 minutes East.

2. The Ince Point tide gauge was operating properly. The general sea level was below the predicted level. At Alert Patches the height of tide was in the region of 0.5m below the predicted height.

3. The full nature of the phenomenon of squat is not fully understood, particularly where the sea bed is irregular and uneven. By reason of the ship's speed the maximum draught forward was probably about 12.1 metres, based on the Netherlands Ship Model Basin Report and the Barras model, but may have been in the region of 13 metres as suggested by the preliminary study undertaken by the AMC Search Ltd.

4. From the basic information carried on the RIVER EMBLEY in the form of charts, tide tables and the Netherlands Ship Model Basin report, the course taken by the ship was apparently safe. Full account and allowance however was not made of other factors as listed 5 to 8 below.

5. The passage plan agreed by the Master, was not fully in accordance with that advised in the Annual Summary of Notice to Mariners Number 22. No courses or optimum speeds were noted and the plan did not apparently extend beyond Ince Point. The advice issued by the Department of Transport as regards the need to maintain (when making way) underkeel clearance of 10% of draught was apparently ignored. The Master knew only in general terms at which point the Pilot intended to alter course. In such confined waters such a general knowledge is not satisfactory.

6. The ship should have maintained a reduced speed of not more than 10 knots through the water in view of the Ince Point height of tide being only 0.08m (8 cm) above that considered as the minimum necessary for safe passage between Nardana Patches and Ince Point. The RIVER EMBLEY was effectively a ship at maximum draught for the passage between Nardana Patches and the eastern exit from the Prince of Wales Channel.

7. It would have been more prudent, in the light of reported shoal water south of Alert Patches and 5 above, for the Pilot to have altered to a more southerly course as soon as the RIVER EMBLEY was able to safely clear O.G. Rock and follow a course close to Herald Patches buoy, being the course more usually followed by the pilot.

8. It can be argued that had the Alert Patches buoy not been moved but had remained on the line of the East Strait Leading lights the Pilot would have altered course, in accordance with his stated normal practice, when off O.G. Rock. It must be taken into account, however, that shoal water was known to exist close north of the East Strait Island leading lights in the vicinity of Alert Patches., the decision to move the buoy was taken in

full consultation with the Queensland Coast and Torres Strait Pilot Service and the shipping industry, and the new position of the buoy was properly promulgated and duly corrected on the ship's chart.

It is generally accepted by mariners and is prudent practice to exercise care in fixing any position in relation to a floating aid. Alert Patches buoy was reported to be I20 metres north of its charted position. It is not clear whether the buoy was laid in this position or whether before or after 9 May it drifted off station. There are no generally accepted international standards of accuracy required for the positioning of buoys. The positional accuracy that needs to be achieved in buoy laying must be related to the hazard involved and the amount of sea room available.

In the circumstances I do not consider that the apparent position of Alert Patches buoy on 9 May 1987, in relation to its charted position, was a contributing factor to the grounding.

9. The Hydrographic survey of the area has been extensive and is accurate within the operational limits of such surveys. The Hydrographer is on record as detailing the limits of the accuracy of the charts of the area and the chart also contains warnings of isolated outcrops of rock between sounding lines.

10. Upon departure Weipa the RIVER EMBLEY was, in all respects, seaworthy.

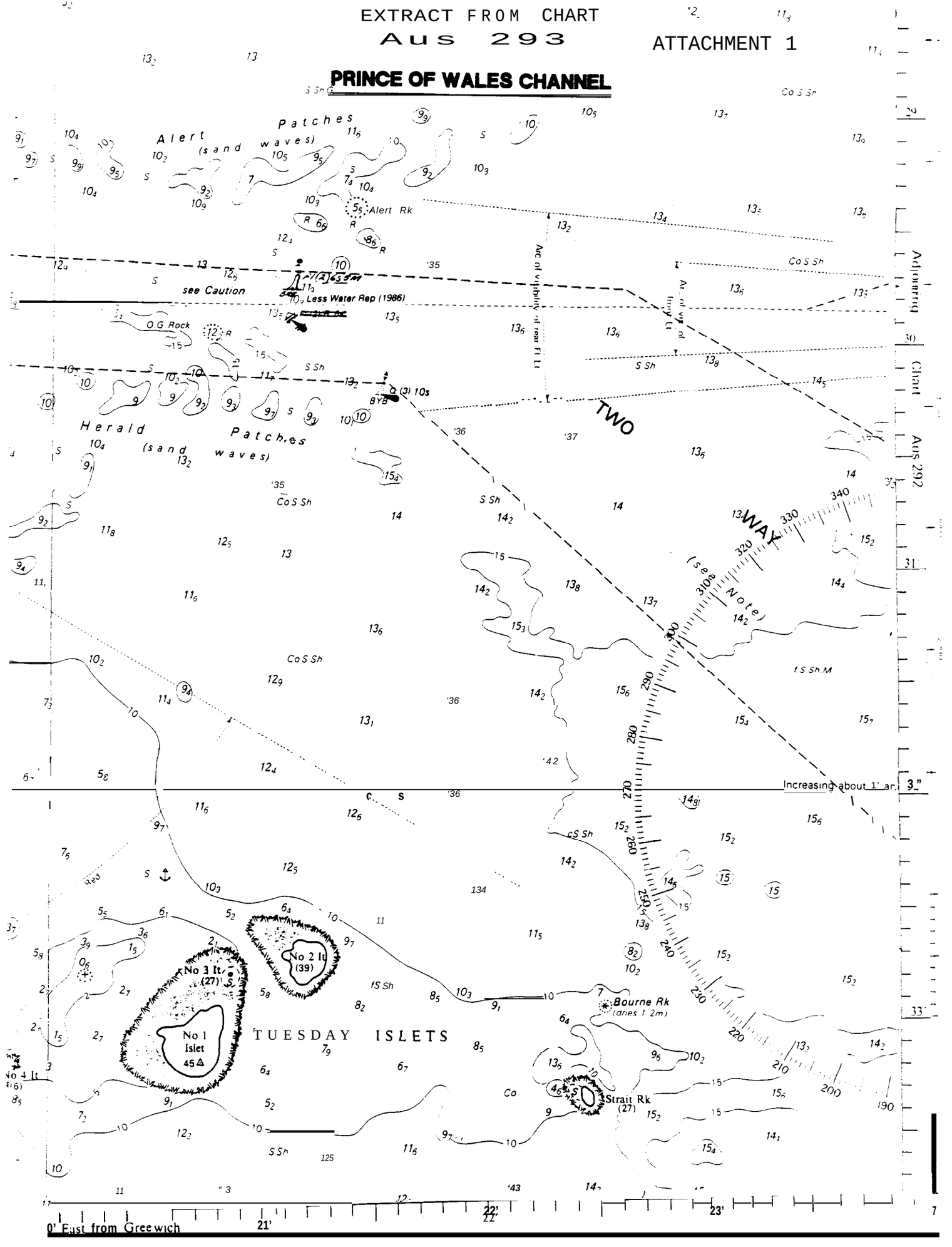
11. The action of the Master and crew after the grounding was correct and seamanlike.

I have carefully considered whether the investigation indicates any degree of negligence or error of judgement. I have concluded that given the benefits of hindsight and access to sources of information not readily available to the parties involved, their action did not amount to negligence or, despite the seriousness of the casualty, to an error of judgement that should attract specific criticism in these findings. The detailed inquiries undertaken clearly point to the need for more careful voyage planning in future, particularly for passages in restricted or partially restricted waters and for full account to be taken of the effects of squat.

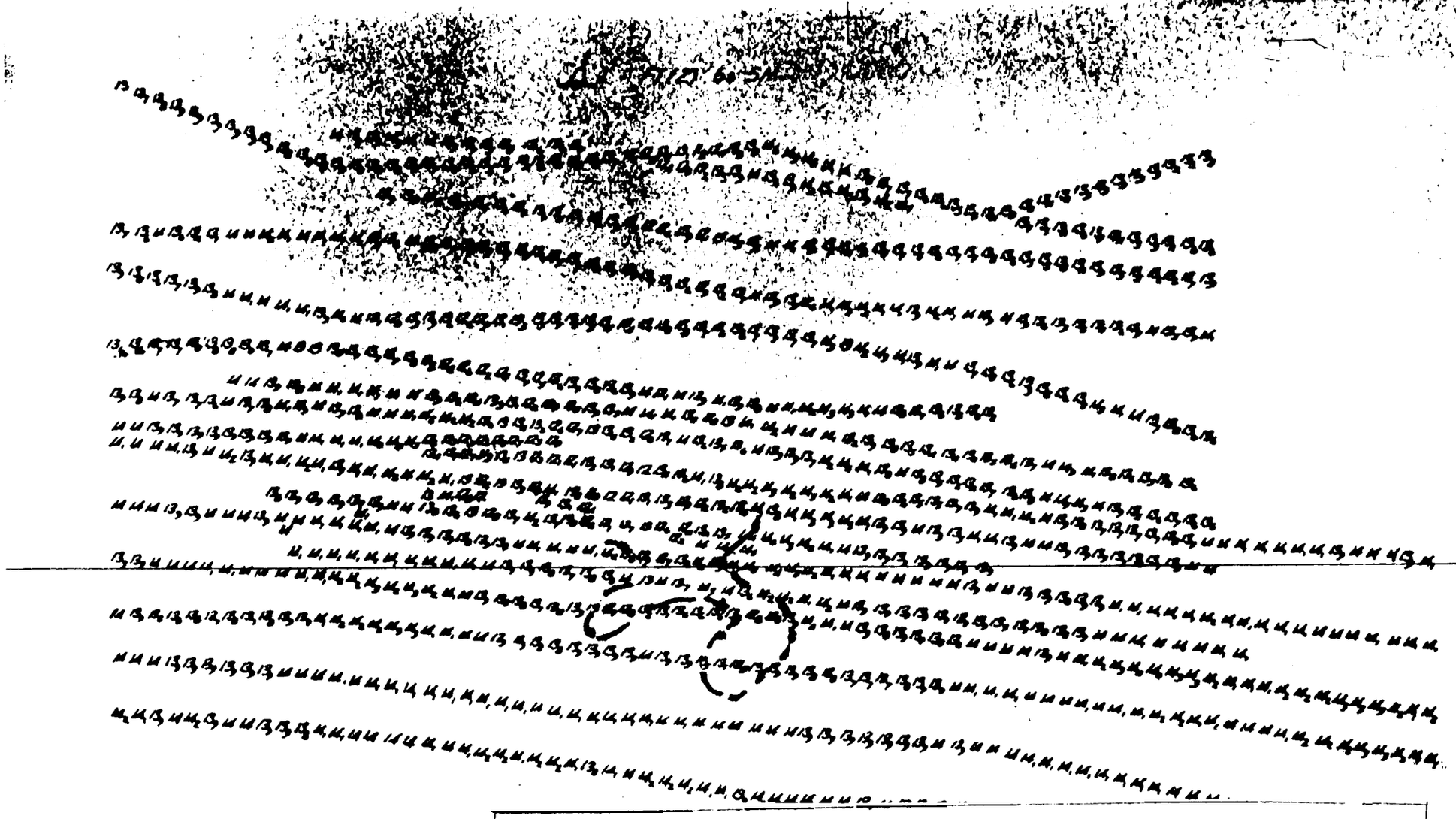
EXTRACT FROM CHART

Aus 293

ATTACHMENT 1



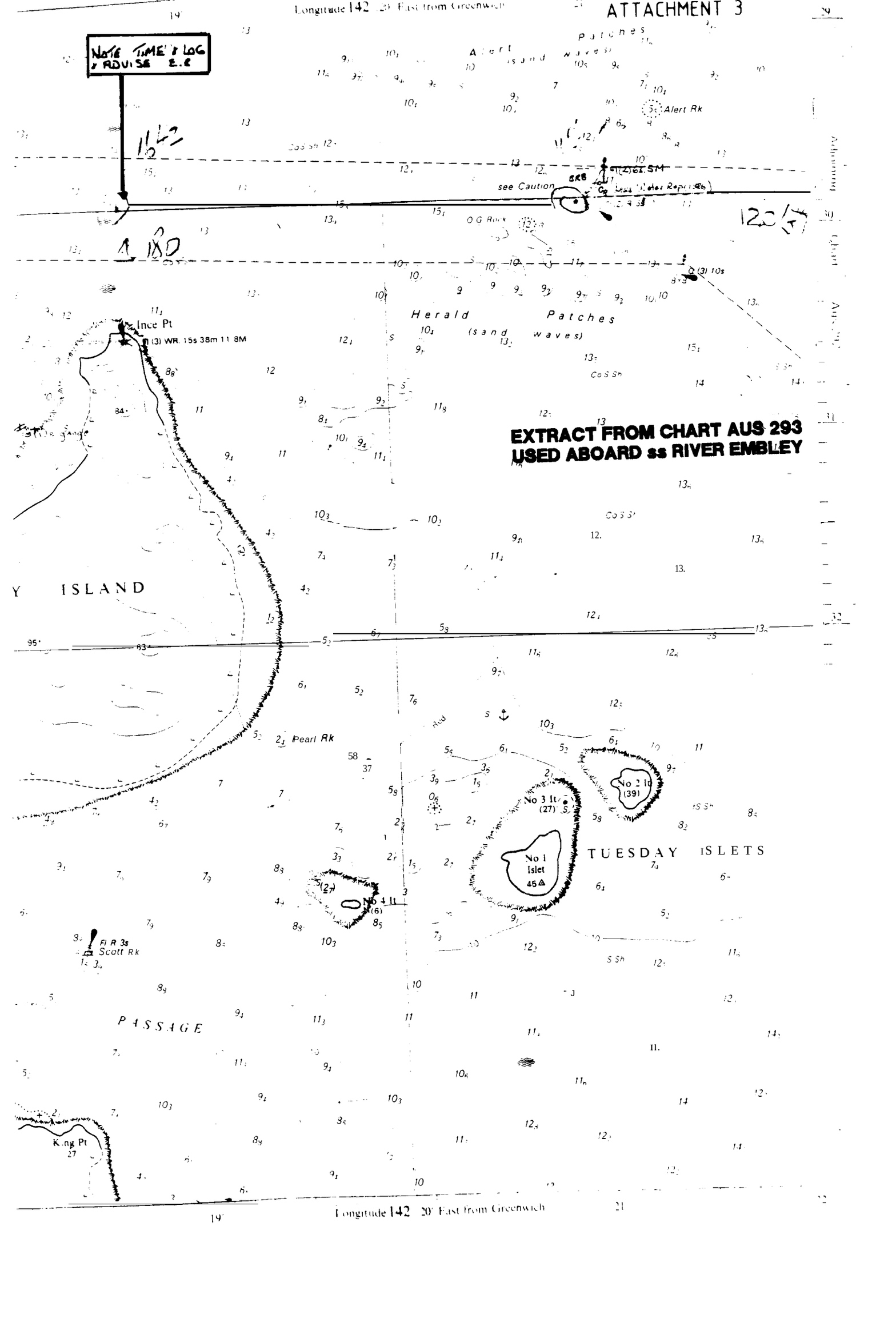
New Edition 30th April, 1983



KEY — Areas of Outcropping Rock as estimated from Echosounder Traces.

GEODETIC DATUM	AGD 66	
DISTANCE APART OF SOUNDING LINES	12 / 25	METRES
SOUNDING ACCURACY	± 4	DECIMETRES
SOUND VELOCITY	1536	METRES PER SECOND

ATTACHMENT 2


ATTACHMENT 3
NOTE TIME & LOG
& ADVISE E.C
Longitude 142° 20' East from Greenwich
Alert Rk
see Caution
O G Rock
Q (3) 10s
Herald Patches
(sand waves)
Ince Pt
Fl (3) WR. 15s 38m 11 8M
EXTRACT FROM CHART AUS 293
USED ABOARD ss RIVER EMBLEY
Pearl Rk
No 3 lt
(27)
No 2 lt
(39)
No 1
Islet
45
No 4 lt
(6)
TUESDAY ISLETS
Fl R 3s
Scott Rk
PASSAGE
King Pt
27
Longitude 142° 20' East from Greenwich

ATTACHMENT 4

Pilot Copy

THE PRINCE OF WALES CHANNEL
TRANSIT AND TIDE TIMES

DATE · 9.5.87 VESSEL: RIVER EMBLEY

TRANSIT BLOCK TIMES AT 8.5 KTS AND 11.5 KTS

B'B; IL° BOARDING GROUND TO HARRISON RK.	17	2.0 H	1.5 H.
HARRISON RK TO NARYANN PATCHES	8	0.9 H	0.7 H
NARYANN PATCHES TO INCE POINT	4	0.5 H	0.4 H
INCE POINT TO E.S. LEADS EXIT	3	0.3 H	0.3 H
TOTAL:	32	3.7 H	2.9 H

	UP TO 11.89 M	TO 12.2 M
UNDER KEEL CLEARANCE (BASIC)	1.0 M	1.22 M ** ONLY
DRAFT	11.0 M	11.00 M.
MINIMUM DEPTH REQUIRED (M.D.R)	12.0 M	12.22 M. HAMMOND ROCK TO INCE PT

ALLOWANCE(S) FOR HEEL; ~~SQUAT~~, STREAM, DIRECT;

	GANNET	GOOPS **	NARYANN **	INCE PT **
M.D.R.	12.0	12.5	12.22	12.22.
DATUMS	10.1	11.2	11.6	11.9
TIDE RISE REQUIRED	+1.9 M	+1.3	+0.62	+0.32
TRANSIT TIMES FROM	0000/1630	ALL DAY	ALL DAY	ALL DAY
TRANSIT TIMES TO	2100/2400	(1800; 1.49 M)	(1700; 1.01 M)	(1700; 0.76 M)

ANCHOR AT — FROM — TO —

HAMMOND ROCK (+) 1539 (1.44) (SLACK) 1754 (−) 2148 (3.9)

PASS GANNET PASSAGE (WEST) · 14.30 PASS HERALD PINNACLES: 1659

TIDE GAUGE: +2.5 M. INCE POINT TIDE GAUGE 0.4 M.

PILOT COPY

M/S.S. RIVER EMBLEY

PORT

TIME.	BOOBY Is.		INCE POINT CH. 88		TURTLE HEAD CH. 87		GOODS Is. CH. 86.	
	PREDICTED	ACTUAL	PREDICTED	ACTUAL	PREDICTED	ACTUAL	PREDICTED	ACTUAL
0900	2.89	2.8						
1000	2.94	2.9						
1100	2.98	2.9						
1130		2.9						
1200	2.96	2.9	2.02		2.21		2.77	
1230		2.9						
1300	2.84	2.8	1.68		2.01		2.62	
1330		0.7						
1400	2.67	2.6	1.38		1.76		2.42	
1430		2.5		0.9	1			
1500	2.46		1.12	0.7	1.49		2.20	
1530				0.6				
1600	2.17		0.87	0.4	1.20		1.9*	
1630				0.4				
1700	1.87		0.76		1.01		1.66	
1730								
1800								

ATTACHMENT 6

"RIVER EMBLEY"

Class and Type:	Steam Bulk Carrier
Official Number:	850352
Home Port:	Sydney
Call Sign:	VJRY
Builders:	Mitsubishi Heavy Industries Nagasaki Shipyard, Japan
Date Launched:	6th November 1982
Date Commissioned:	15th June 1983
Length Overall:	255m
Length between Perpendiculars	248m
Breadth:	35.35m (moulded)
Depth:	18.3 (moulded)
Load Draught: (Summer Freeboard)	12.325 m
Load Displacement:	94,455 Tonnes
T.P.C. (Loaded):	80.4
Deadweight:	76,305 Tonnes
Net Tonnage:	16,346
Gross Tonnage:	51,035
Machinery:	One Mitsubishi MS-21-2 Steam Turbine Two Mitsubishi C.E. VZM-9S Coal-fired Boilers
Propeller:	One highly skewed, fixed pitch
Power Maximum:	14,000 kW
Power Service:	9,500 kW (loaded), 8,000kW (ballast)
Service R.P.M.	72 (loaded), 70 (ballast)
Service Speed:	14.0 Knots
(ballast)	14.5 Knots
Bunker Capacity:	3,670 Tonnes
Type of Fuel:	Coal at 5525 k.cal/kg
Daily Sea Consumption: (typical)	220 Tonnes (loaded), 200 Tonnes (ballast)
Daily Port Consumption: (typical)	80 Tonnes
Complement:	33

APPENDICES

Appendix 1

Warnings and Notices

Warnings of navigational hazards are, in the first instance, broadcast by radio to ships in the form of an "Auscoast".* These are withdrawn when the hazard is removed or confirmed by Australian Notice to Mariners. Three notices of direct relevance to the Torres Strait are promulgated each year in the Annual Summary of Australian Notices to Mariners. These are:

Notice No 18 - Under Keel Clearance - Reliance on Charts and Predicted Tides

Notice No 22 - Navigation in the Great Barrier Reef

Notice No 23 - Queensland Coast and Torres Strait Pilot Service

Ships transitting Torres Strait are limited to a maximum draught of 12.2 metres. This permits ships with this draught to transit Torres Strait at a certain time on each day of the year, providing the predicted height** of tides are achieved, allowing the underkeel clearance detailed in Notice to Mariners No 23. This maximum draught was increased in August 1981 from a maximum of 11.9 metres.

* AUSCOAST	A radio navigational warning issued by the Federal Sea Safety and Surveillance Centre through a coast radio station.
** PREDICTED HEIGHT OF TIDE	An estimation of a tide which can be made years in advance and includes astronomical and seasonal parameters.

CSSO600423

18. UNDER-KEEL CLEARANCE - Reliance on Charts and Predicted Tides

1. The limitations of hydrographic surveys are discussed at length in the *Muriner's Handbook (NP 100) 5rh Edition, 1979,* also describes the danger of negative tidal surges. These, and other factors affecting tide levels, are further described in the introduction to the *Australian National Tide Tables..*

2. It has become increasingly evident that economic pressures are causing mariners to navigate through waters of barely adequate depth, under-keel clearance being finely assessed from the charted depths and predicted tide levels.

3. It cannot be too strongly emphasised that even charts based on modern surveys may not show all sea-bed obstructions or the shoalest depths and actual tide levels may be appreciably lower than those predicted.

4. Hydrographic surveys have inherent technical limitations, due partly, in off-shore areas, to uncertainties in the tidal reductions. Furthermore, in some areas the shape and hence the depth of the sea-bed is constantly changing. Nautical charts can seldom, therefore, be absolutely reliable in their representation of depth - and when tidal predictions are applied to the chart as if they were actual tide levels, the uncertainties are clearly compounded.

5. Prudent mariners allow for navigational uncertainties by preserving adequate clearance, both horizontally and vertically.

RAN Hydrographic Service. (AH56/116)

22. NAVIGATION IN THE GREAT BARRIER REEF

The Great Barrier Reef Marine Park

1. The Great Barrier Reef, the world's largest living coral reef system, has been placed on the World Heritage List. In order toprotect the marine life of the area, the Australian Government has declared most of the waters of the region to be sections of the Great Barrier Reef Marine Park.

2 Activities in the Marine Park are regulated by zoning plans which define the purposes for which the various zones may be entered. Copies of the zoning plans may be obtained from:

The Great Barrier Reef Marine Park A.Ithority
P.O. Box 1379
TOWNSVILLE, QLD. 4810

3. The International Maritime Organization (IMO) has accepted the area of the Capricorn and Bunker groups of islands and reefs in the southern part of the Great Barrier Reef as an Area to be Avoided. Its limits are shown on appropriate charts.

Passage Planning

4. As for all passages, a detailed navigational plan for the passage through the waters of the Great Barrier Reef and Torres Strait should be prepared before the passage is commenced, following the principles of *.-l Guide lo the Planning and Conduct of Sea Passages* (Her Majesty's Stationery Office and available through chart agents) or a similar guide.

5. The passage through these waters involves navigation through confined waters for a long period, the particularly restricted area being about 500 miles in length. As it is not possible for the master to be in sole charge of the navigation for this period. the officers of the watch also must be familiar with the navigational plan and capable of following it in the master's absence from :he bridge.

Two-way Route

6. Between Low Islets (16° 23' S. 145° 33' E) and Booby Island (10° 36' S. 141° 55' E) a two-way route has been established for use by ships of medium draught. Details of this route and explanatory notes are giLen on the appropriate large-scale navigational charts.

Pilotage

7. *Notice No. 23* gives details of pilotage services available for the Great Barrier Reef, Torres Strait and Greit North East Channel and Hydrographers Passage. In February 1986 the Maritime Safety Committee of IMO issued MSC/Circ. 430 recommending that ships of 100 metres in length and over and all loaded oil tankers, chemlcal tankers or liquefied gas carriers irrespective of size use the pilotage service provided by the Queensland Coast and Torres Strait Pilot Service when navigating in the Torres Strait and inner route of the Great Barrier Reef area between Booby Island (IO"36' S. 141°54' E) and Latitude 16°40' S or through the Great North East Channel, or Hydrographers Passage.

8. The Federal Department of Transport further recommends that masters not familiar with other areas of the Great Barrier Reef or the entrances Palm Passage and Grafton Passage also use the Pilot Service.

Transport, Canberra. (AH 70/116, 56/116, 571116, 581116)

Appendix 2

Depths and Underkeel Clearance

The part of the passage regarded as the most critical lies between the entrance to Gannet Passage, where there is maximum depth at chart datum* of lOm, and throughout the Gannet Passage and Prince of Wales Channel as far as Ince Point where depths of between llm and 12m are extensive. Soundings in the area of Alert Patches north of the leading line from East Strait Island leading lights** have also shown there to be water in the region of llm.

To make the passage, therefore, ships drawing over 9 metres are dependent on a tidal window to navigate Torres Strait. In essence a ship is required to maintain an underkeel clearance of 1 metre in Gannet Passage and maintain at least 1.22 metres thereafter. To achieve this clearance it is necessary for deep draught ships to proceed at reduced speed in areas of restricted depth. The slower speed of the ship through the water reduces the phenomena of "squat".

* CHART DATUM	The level to which soundings are reduced for the preparation of a chart. It approximates to the sea level at normal low water spring tides.
** LEADING LIGHTS	Lights at different elevations so situated as to define a leading line when brought into transit.

CSS0600423

Appendix 3

Squat

The term squat refers to the tendency of a ship to sink lower in the water and change trim with an increase of forward speed. Squat therefore reduces the static underkeel clearance. The phenomenon of squat is experienced by all ships but is critical where ships are navigating in areas of shallow water. Squat is a function of the ship's block coefficient* and speed. The factor of underkeel clearance as expressed by a factor of depth of water divided by ship's draught is also relevant. The RIVER EMBLEY at 11 metres static draught would have experienced a factor of 1.23. Using a simple formula developed by Professor Barras, or graphs developed by other authorities, an approximation of the deepest draught underway can be assessed.

The preface to the Torres Strait Tide Tables advises that the pilot service will accept for pilotage vessels with draughts not exceeding 12.2 metres provided that an underkeel clearance of at least 1 metre is maintained in Gannet Passage, thereafter 10 percent of draught. Based on predicted tidal height, ships at this draught are able to transit the Strait at some time during any day in the year. The term 'maintain an underkeel clearance' refers to the need to make allowance for squat and all other factors affecting draught in addition to the static draught to ensure the 1 metre and 10 percent clearances is maintained at all times throughout the passage.

The Australian National Line based assessment of squat on tests carried out by the Netherlands Ship Model Basin, Wagenngen. The closest model was for the ship drawing 12.2 metres of water at 15 metres static draught. The depth/static draught (H/T) factor of 1.23 is the same as that relevant to the RIVER EMBLEY on 9 May. For the purposes of this investigation, the propulsion test curve for the bow is considered relevant.

* BLOCK COEFFICIENT — The factor relating the volume of a ship s hull to that of a box of the same overall dimensions. It is defined as :

$$\text{CB (River Embley)} = \frac{\text{Displacement}}{\text{Water density} \times \text{LBP} \times \text{Breadth Moulded} \times \text{draught}} = \frac{83150}{1.025 \times 248 \times 35.35 \times 10.94} = 0.846$$

CSS0600423

23. AUSTRALIA — QUEENSLAND — Queensland Coast and Torres Strait Pilot Service — Draught Limitation and Service Advice.

I. The Queensland Coast and Torres Strait Pilot Service will pilot vessels through Gannet Passage and Prince of Wales Channel, Torres Strait with a maximum draught of 12.2 metres.

1. The minimum underkeel clearances are:

(a) Gannet Passage — 1.0 metre.

(b) Prince of Wales Channel — 1.0 metre for vessels Hith a draught of 11.89 metres or less: 10% of draught for vessels with a draught exceeding 11.89 metres.

3. The draught limitation of 12.2 mrtres applies only to Lessels entering or leaving the Great Barrier Reef Inner Route by say of *Torres Strait* or the *Great North East Chonnel.*

4. Vessels entering or leaLing the Inner Route by way of *Grafton, Palm* and *Hydrographers Passages* are restricted only by any draught limitation at the Australian port of arrival or departure.

55 *Pilot Advice - Torres Strait.*

(a) *South and East Bound.*

(i) Pilots board 3.5 miles West of Booby Island or 2.5 miles West of Goods Island. Vessels requiring pilots should give 4 to 5 days notIce LO *TORRES SYDNEY* advising E.T.A., at Booby or Goods pilot station, maximum draught and desrlnarion.
Confirmation or adjustment of the E.T.A. should be sent direct to *TORIND TLX 48822, THURSDAY ISLAND* - 24 and 6 hours prior to arrlval, giving local time which is GMT + 10 hours.

(ii) Pilot Station — Call sign *Reef Pilots* maintains watch on VHF Channel 16. Pilot launches maintain UHF iiatch on Channel 16 when on station.

(iii) All ships traversing the pllotage district should maintain a continuous VHF watch on Channel 16.

(b) *North and West Bound.*

(i) If in an Australian port, advise *TORRES SYDNEY* of pilotage requirements, giving as much notice as posslbie.

Ii) If from an overseas port, advise *TORRES SYDNEY* 4-5 days in advance of pilotage requirements, stating E.T.A. (name of boarding place). maximum draught and destination. Confirm or adjust E.T.A. 48 and I2 hours before arrival to *TORRES SYDNEY.*

(iii) Pilot can board at any port in New South Wales and Queensland or:
Off Port Moresby — Basilisk Beacon for the Great North East Channel — launch service.
Off Point Cartwright (Brisbane Pilot Station) — launch service.
Off North Point Gladstone (23° 44'.0 S, 151° 21'.5 E) - launch service or helicopter land-on operation.
Off Cairns fairway (16° 49' S, 145° 50' E) - launch service or helicopter land-on operation.
Any other port or place by arrangement with *TORRES SYDNEY.*

6. Pilotage Advice — Reef Entrances.

(a) Grafton Passage pilot ground off Euston Reef (16° 39' S, 146° 14' E) - launch service or helicopter land-on operation.

(b) Palm Passage pilot ground off Pith Reef (18° 13' S, 147° 07' E) - helicopter land-on launch service or operation.

(c) Hydrographers Passage pilot ground off Blossom Bank (19° 47' S, 150° 24' E) - helicopter land-on operation.

7. Pilotage requirements should be advised to *TORRES SYDNEY* similarly to instructions in 4(b)(i) and (ii), except where special instructions may be given by *TORRES SYDNEY.*

8. Federal DepartmeW of Transport Recommendation on Pilotage.
Refer —

(a) *Nolice No. 22.*

(b) Federal Department of Transport *Hydrographers Passage Sailing Directions — Second Edition November 1985 Sec. 1:11 and Chapter 3.*

Harbours and Marine, Brisbane.
Queensland Coast and Torres Strait Pilot Service. (AH 70/116)

SINKAGE

SHIP MODEL 5007

DRAFT 12.20 m

——— PROPULSION TEST No. 9924

- - - Restistance TEST No. 99 19

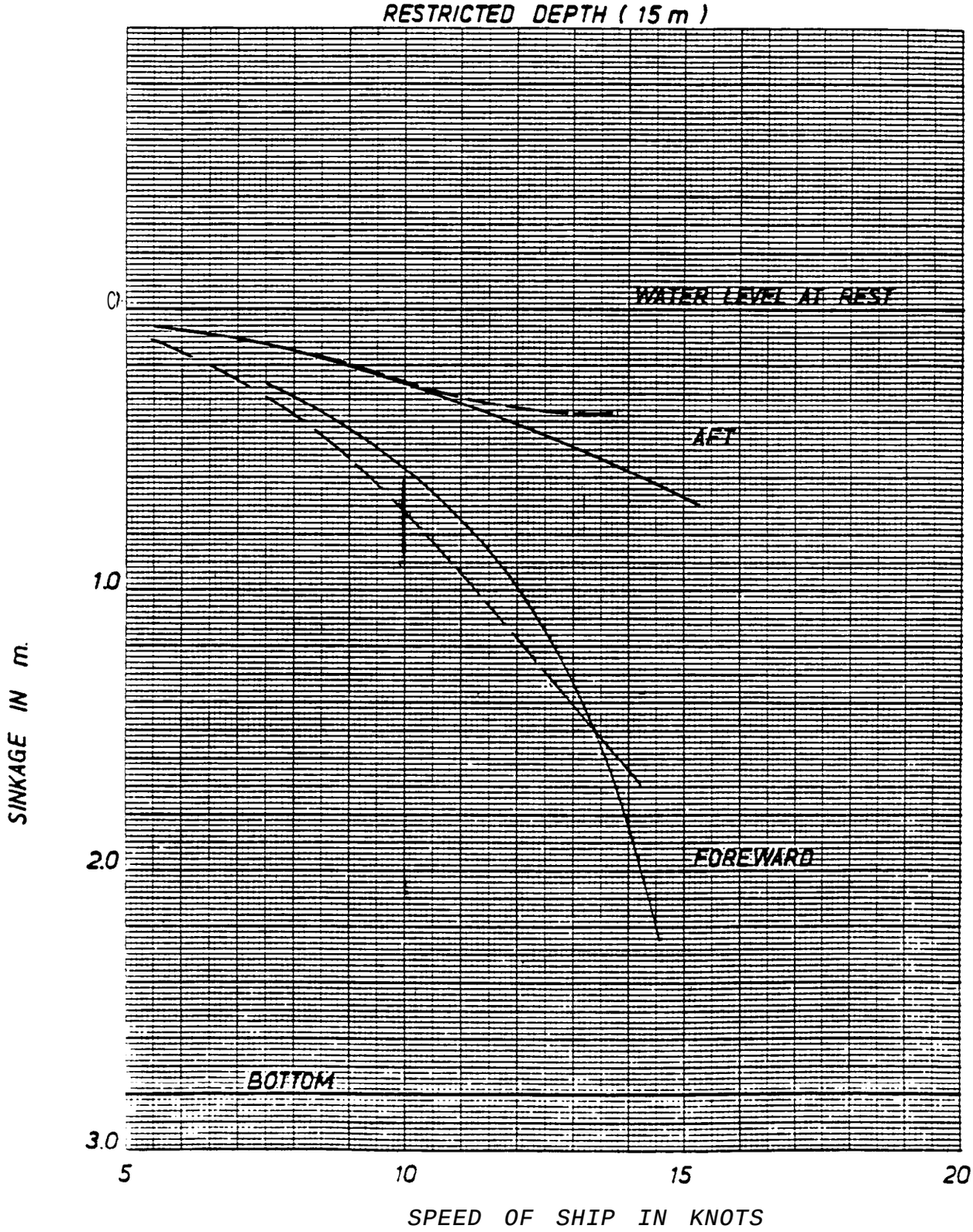


DIAGRAM No. M 5807 - 02

BARRAS FORMULA

The formula developed by Professor G.B. Barras is based on 300 measure of various vessels in trim conditions from that of even keel to being the stern. The formula for open still water conditions with a depth/draught ratio of between 1.10 and 1.20 is:

$$\text{Maximum squat} = \frac{Vk^2 \times C_B}{}$$ (Vk^2 ships's speed in knots in still water)

Given a block coefficient (CB) of 0.846 the maximum squat would therefore be:

i at 12 knots

$$S = \frac{12^2 \times 0.846}{100} = 1.22 \text{ metres}$$

ii at 12.5 knots

$$S = \frac{12.5^2 \times 0.846}{100} = 1.32 \text{ metres}$$

AMC STUDY

The AMC study is based on existing data for similar formed vessels and is not intended to be a full and complete study of the sinkage of the RIVER EMBLEY. The method used was originally developed for large tanker-like forms. British Maritime Technology uses this method finding it applicable to ships with lower block coefficients than large tankers.

A PRELIMINARY STUDY OF THE

SQUAT OF A 248 METRE LONG VESSEL

IN SHALLOW WATER

(by AMC Search Ltd Launceston
- commissioned by Department of
Transport 26 May 1987)

JUNE 1987

CSSO600423

INTRODUCTION

When a surface ship is underway the total pressure on its hull is altered due to the effect of the dynamic pressure caused by its motion. In addition to causing drag the change in pressure provides a trimming moment and a heave force which collectively affect the running trim of the vessel. For a conventional displacement craft this results in an increased draft and, generally, an increased trim by the head.

The presence of any restriction to the flow will result in an increased flow velocity and hence a lower dynamic pressure. In practice, this occurs when a vessel travels in shallow water and the resulting increase in sinkage and trim is known as SQUAT.

In order to investigate the anticipated sinkage for a 248m long vessel travelling at an approximately level draft of 10.94m a preliminary study was undertaken utilising the method developed by Dand (Reference 1) for similar hull forms. It must be emphasised that this is a preliminary study only, based on existing data for constant vessel speed and water depth. The effect of varying water depth is known to adversely affect the dynamic draft and to take this into account, model experiments would be required.

METHOD

The bow sinkage and stern sinkage values against speed were obtained for the water depths 11.5 -> 15m at half metre intervals. In all cases the stern had less sinkage than the bow and since it would therefore not ground until after the bow the sinkage of the stern was not considered further.

From the sinkage at the bow in the different conditions the Bow Underkeel Clearance was obtained. (Figures l-8).

Using Figures l-8, it was possible to estimate the speed at which grounding would occur for each water depth and this was plotted in Figure 9 as the speed for grouding against water depth.

CONCLUSION

The estimated speed required to cause grounding is plotted in Figure 9 against water depth using the method given in Reference 1.

It is emphasised that this is estimated from existing data and that for an accurate prediction model tests should be carried out using the correct hull form.

If it were intended to operate a vessel of this size in condition which would approach those shown as causing grouding in Figure 9 then it is strongly recommended that a further study involving model tests be carried out.

REFERENCE

1 Dand, I.W., Estimating the bow and stern sinkage of a ship underway in shallow water, The Naval Architect, January 1973.

CSS06D0423

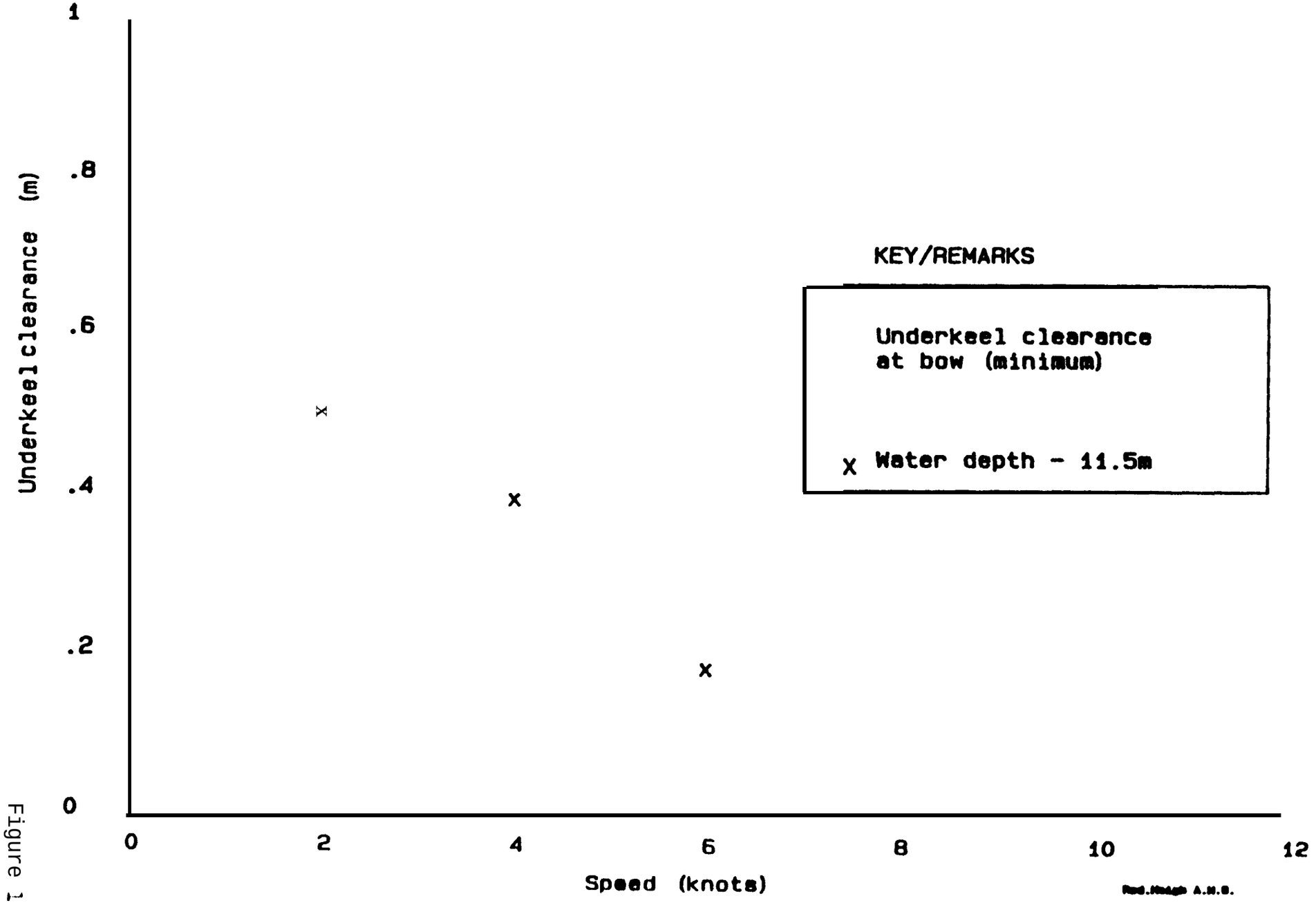

1
.8
.6
.4
.2
0
Underkeel clearance (m)
0
2
4
6
8
10
12
Speed (knots)
KEY/REMARKS
Underkeel clearance at bow (minimum)
x Water depth - 11.5m

Figure 1

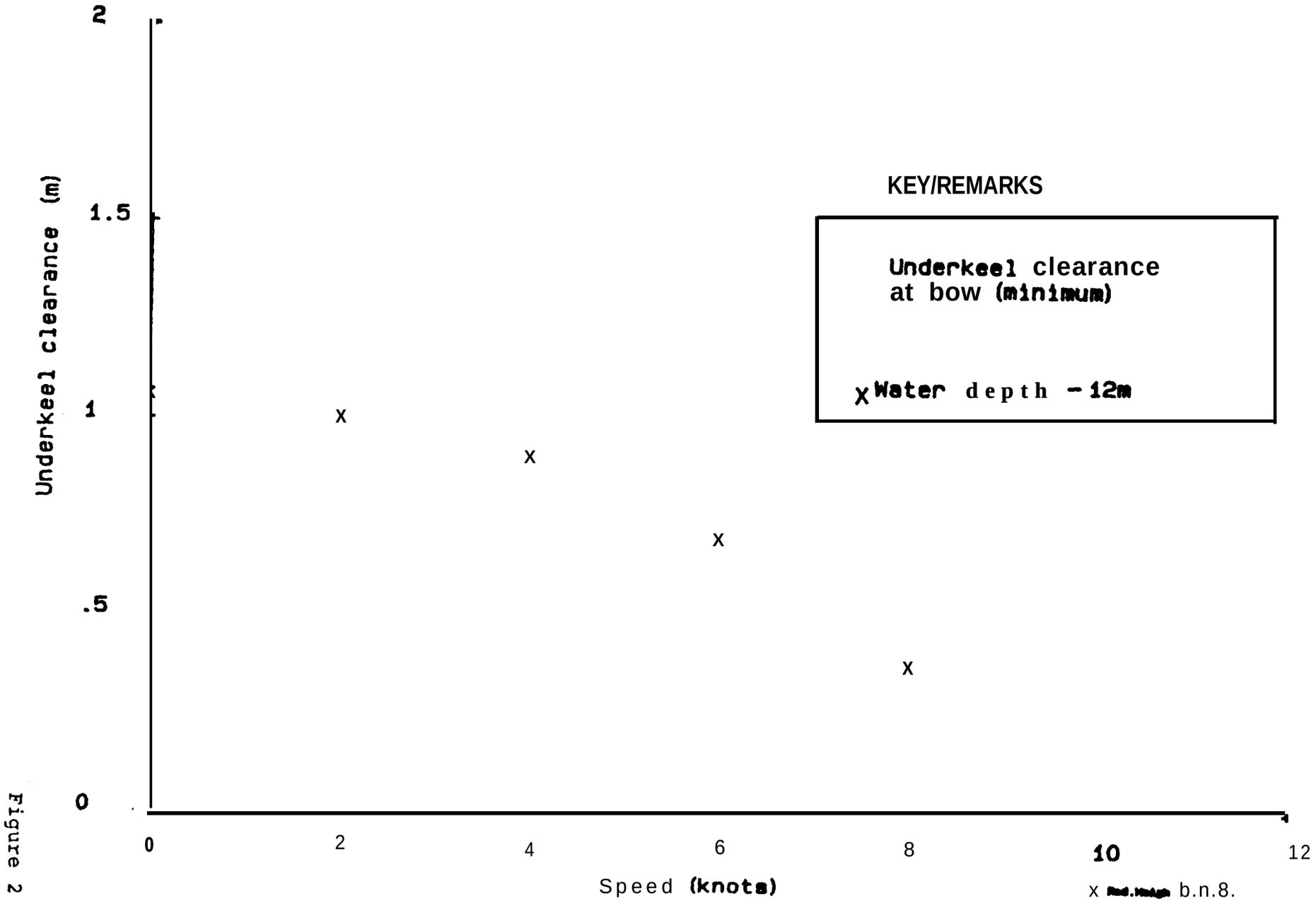

Underkeel clearance (m)
2
1.5
1
.5
0
0
2
4
6
8
10
12
Speed (knots)
KEY/REMARKS
Underkeel clearance at bow (minimum)
x Water depth - 12m
x max. height b.n.8.

Figure 2

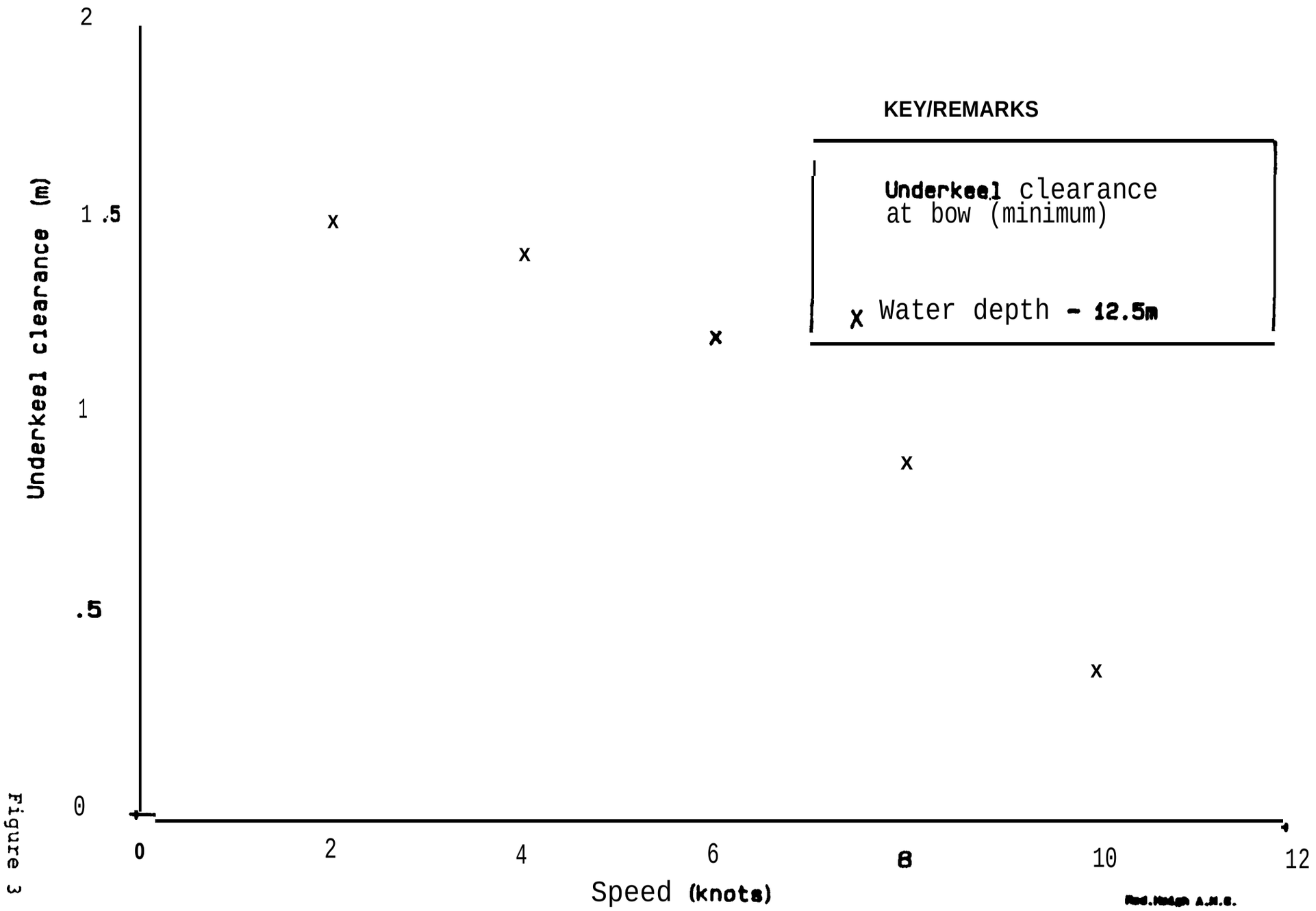

KEY/REMARKS
Underkeel clearance at bow (minimum)
X Water depth - 12.5m
Underkeel clearance (m)
2
1.5
1
.5
0
0
2
4
6
8
10
12
Speed (knots)

Figure 3

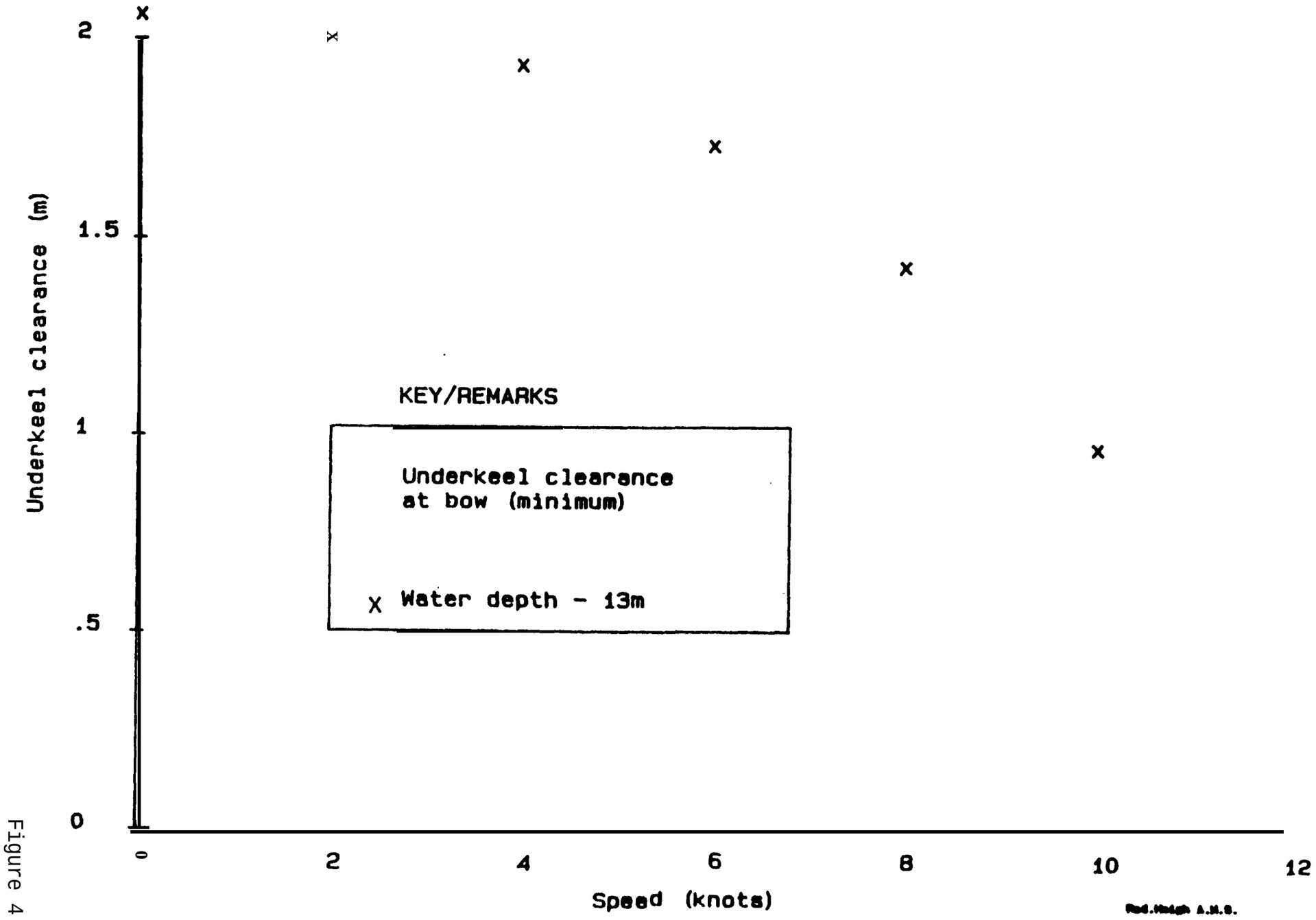

Underkeel clearance (m)
2
1.5
1
.5
0
0
2
4
6
8
10
12
Speed (knots)
KEY/REMARKS
Underkeel clearance at bow (minimum)
X Water depth - 13m

Figure 4

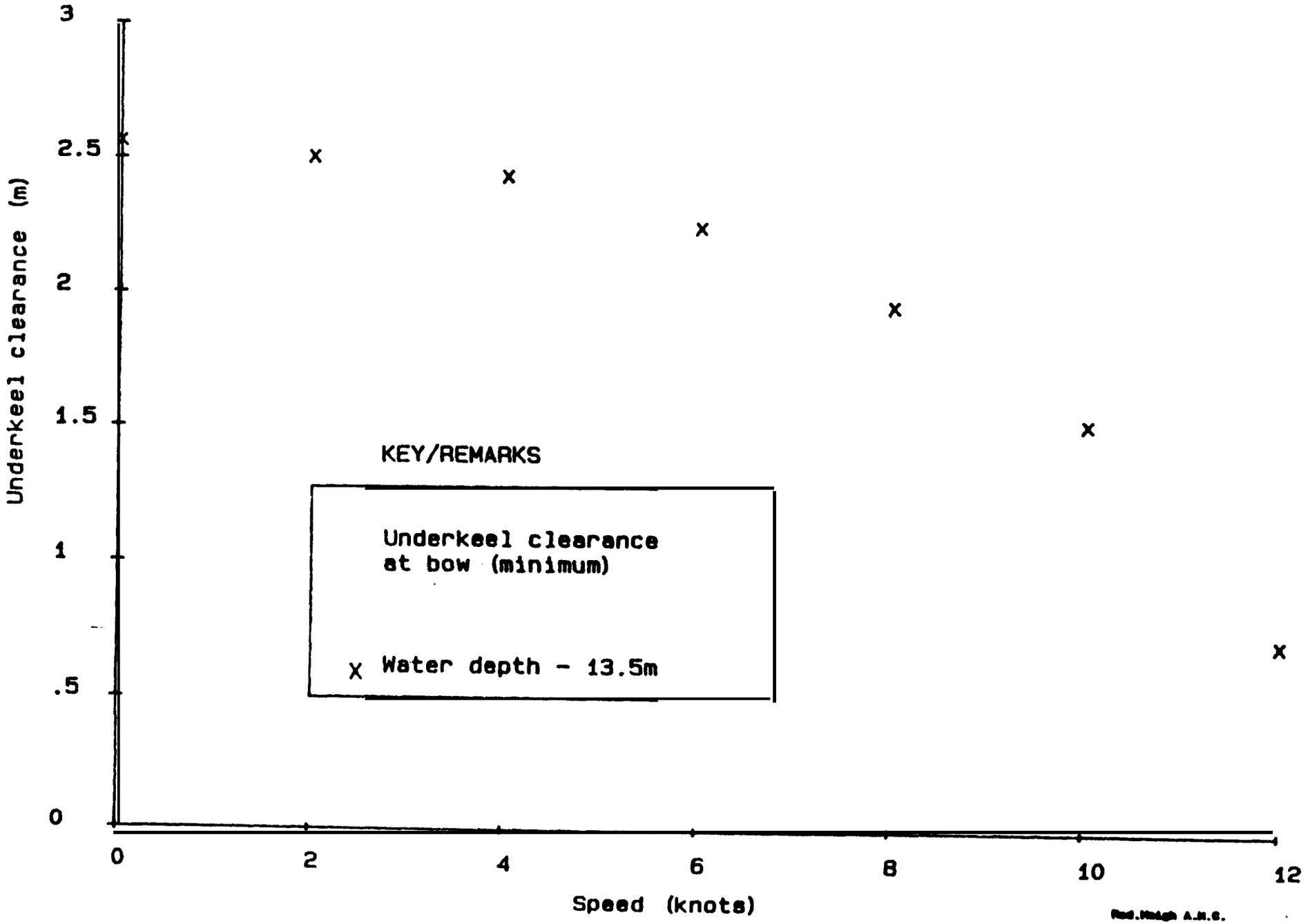

Underkeel clearance (m)
3
2.5
2
1.5
1
.5
0
0
2
4
6
8
10
12
Speed (knots)
KEY/REMARKS
Underkeel clearance at bow (minimum)
Water depth - 13.5m

Figure 5

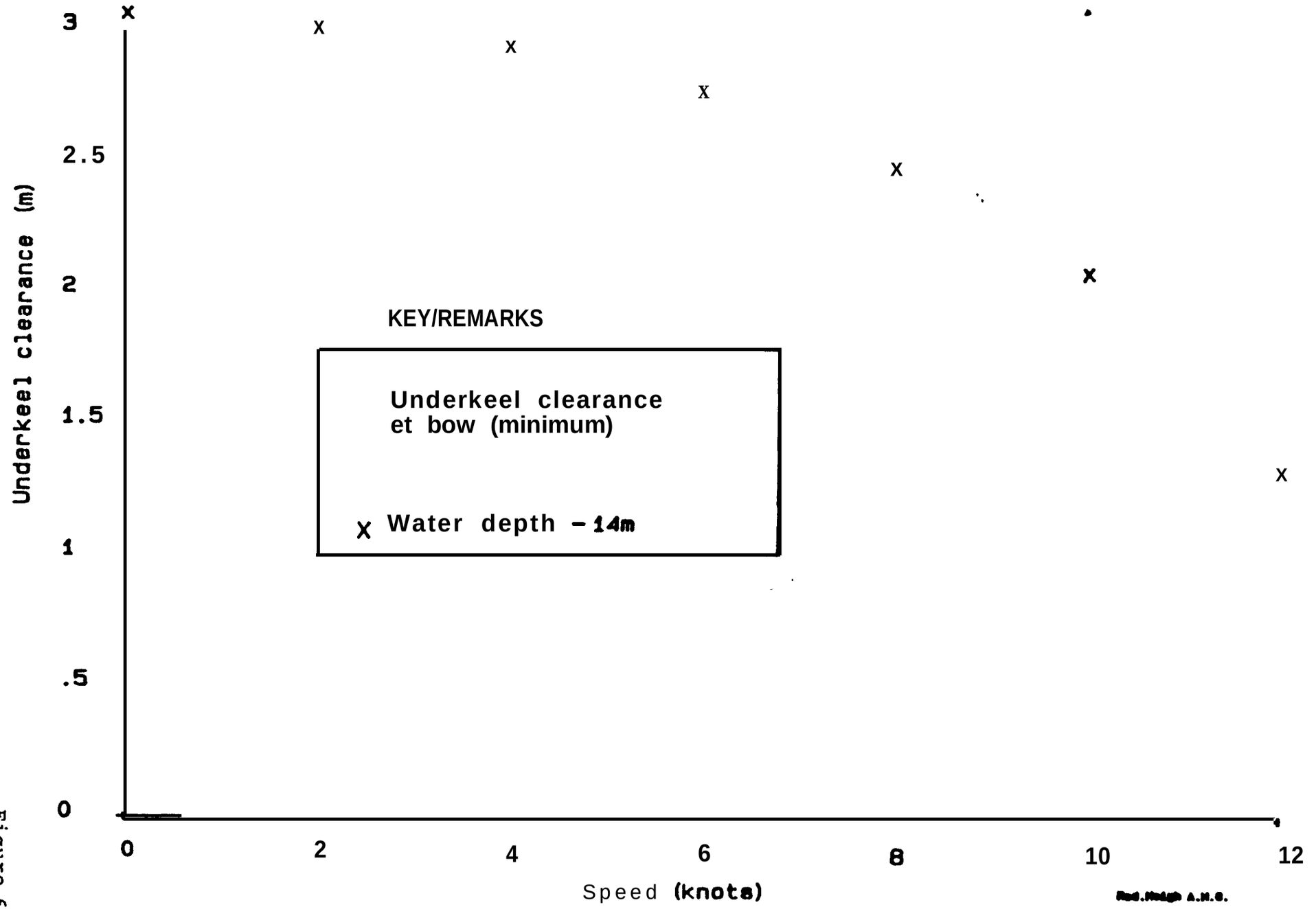

Underkeel clearance (m)
3
2.5
2
1.5
1
.5
0
0
2
4
6
8
10
12
Speed (knots)
KEY/REMARKS
Underkeel clearance et bow (minimum)
X Water depth – 14m

Figure 6

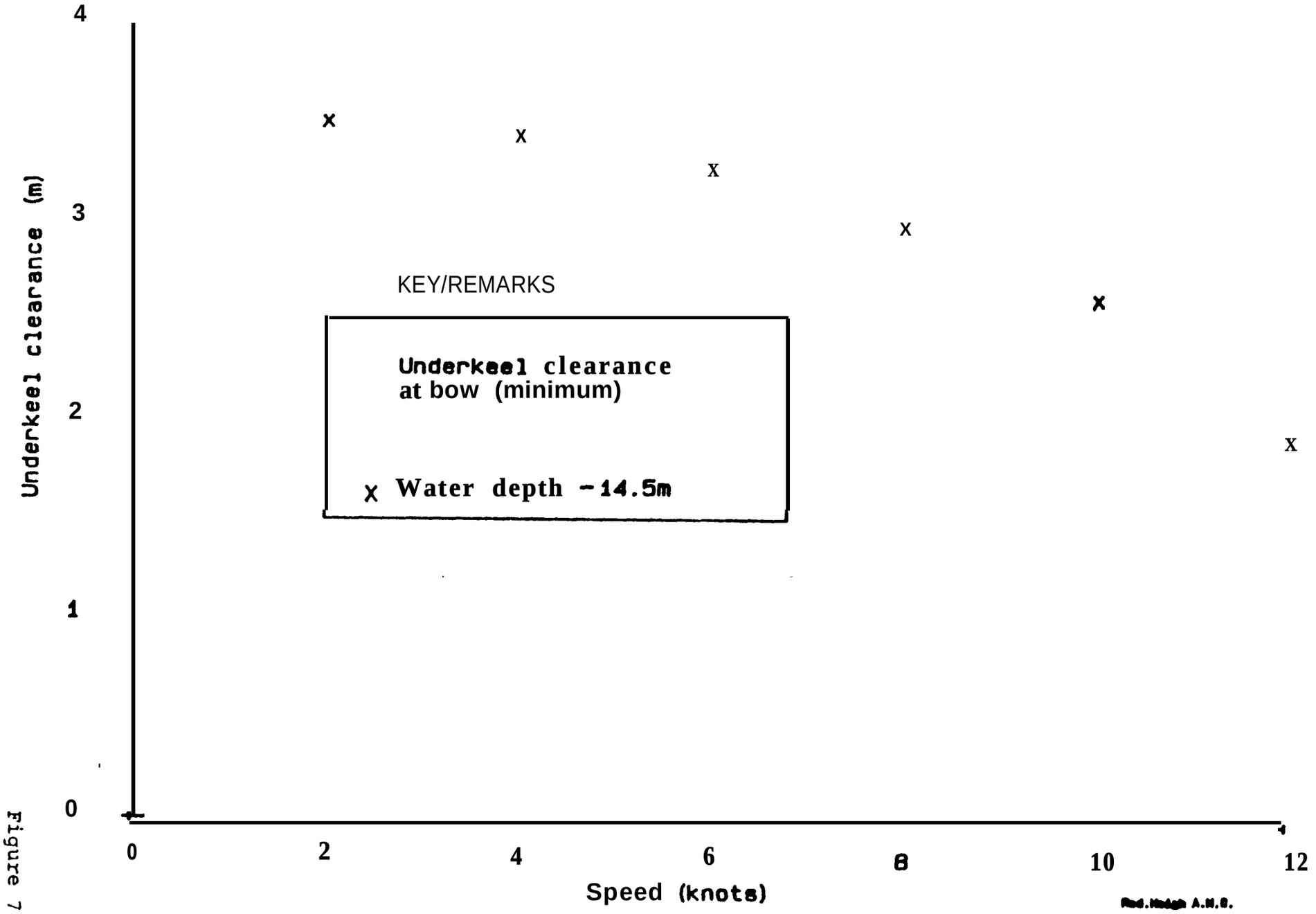

Underkeel clearance (m)
4
3
2
1
0
KEY/REMARKS
Underkeel clearance at bow (minimum)
x Water depth -14.5m
0
2
4
6
8
10
12
Speed (knots)

Figure 7

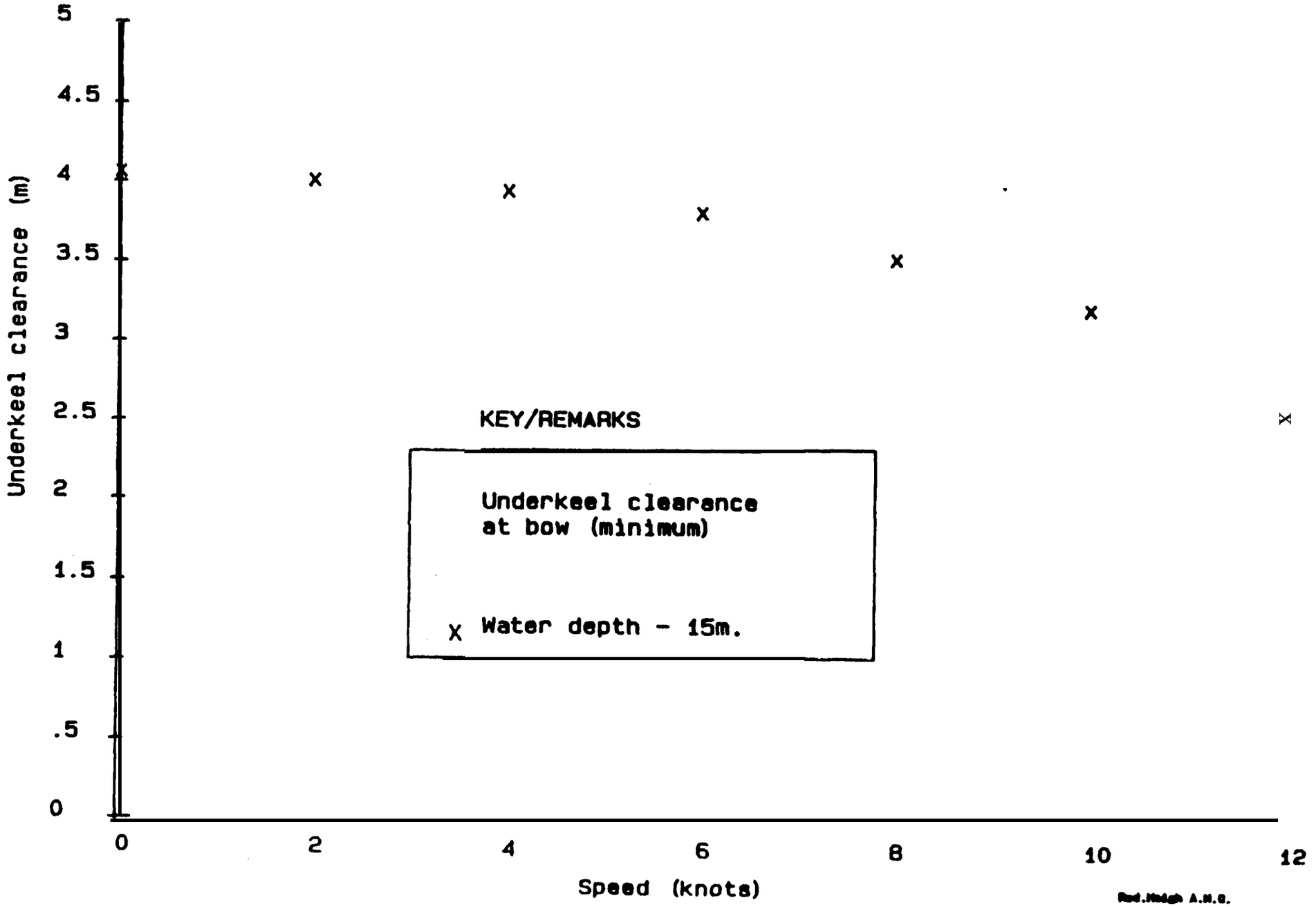
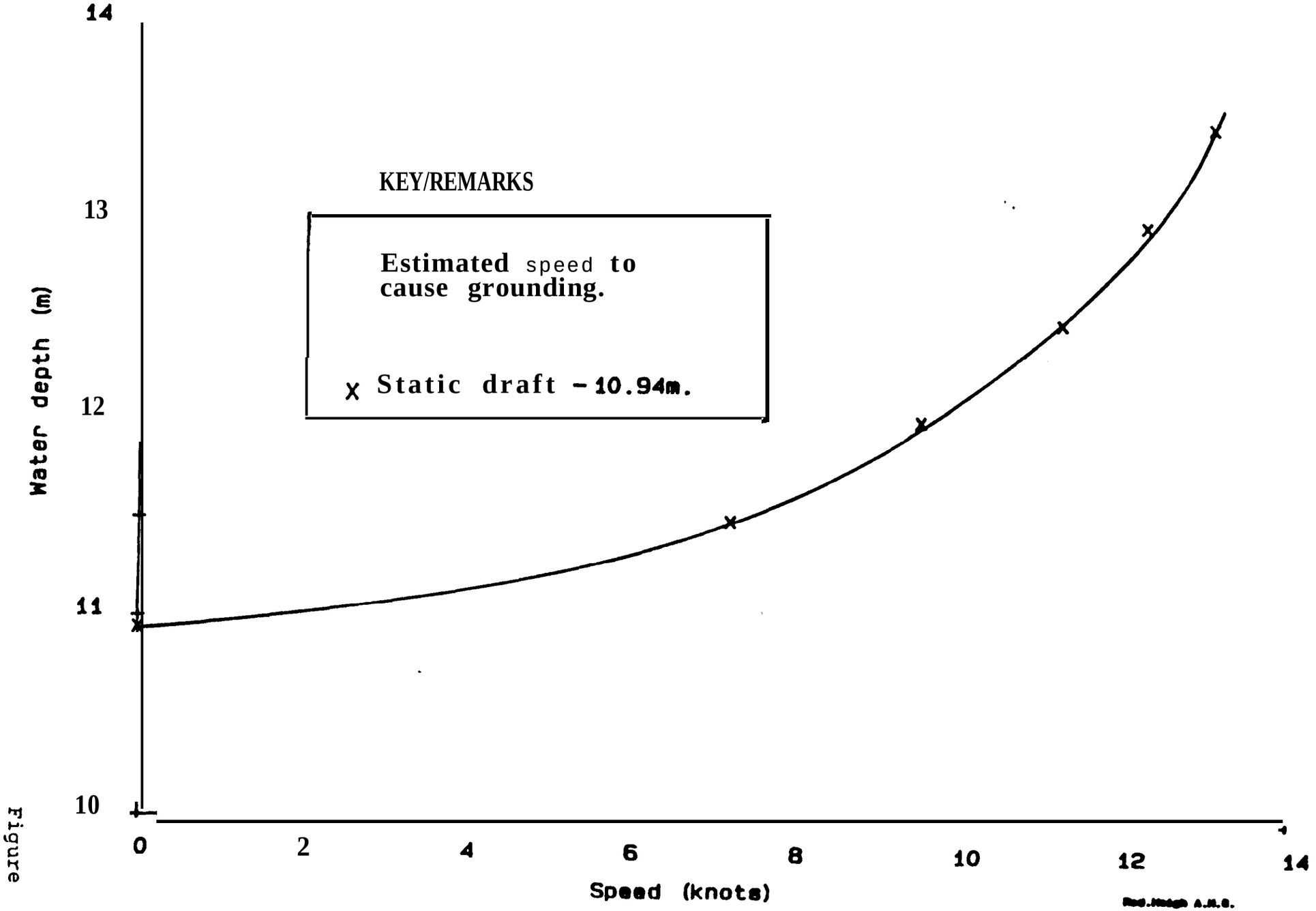

Underkeel clearance (m)
5
4.5
4
3.5
3
2.5
2
1.5
1
.5
0
0
2
4
6
8
10
12
Speed (knots)
KEY/REMARKS
Underkeel clearance at bow (minimum)
Water depth - 15m.

Figure 8


14
13
12
11
10
Water depth (m)
KEY/REMARKS
Estimated speed to cause grounding.
x Static draft - 10.94m.
0
2
4
6
8
10
12
14
Speed (knots)

Figure

Tidal Information and Gauges

To aid the ship master and pilots navigating the Torres Strait the Department of Transport issues annually the Torres Strait Tide Tables giving hourly predictions for every day of the year at specific locations in the Torres Strait and Great North East Channel. The locations relevant to this investigation are Booby Island, Goods Island, Turtle Head and Ince Point. In conjunction with the tidal predictions contained in the tables, transmitting tide gauges have been established at Booby Island, Goods Island, Turtle Head and Ince Point which broadcast the actual height of tide* at four or five minute intervals.

At Booby Island the tidal height is transmitted through the radio beacon on a frequency of 320 kHz. The transmission sequence is as follows:

(i) Identification Signal (morse VND)	3 minutes
(ii) Booby Island Tide Information	2 minutes

During transmission of Booby Island tide information, the word TIDE is sent twice, in slow morse, followed by a dot for each metre of tide, a space, then followed by a second series of dots representing tenths of a metre. Zero is represented by a morse dash. The transmitted values represent the measured tide height above Chart Datum (see Table of Datums). The complete signal is repeated every 5 minutes.

The other tide gauges each transmit on a discrete frequency in the VHF Maritime Radio Band. The tide information is updated at approximately 4 minute intervals and the format is similar to that used at Booby Island.

Goods Island tide gauge broadcasts on VHF Channel 86 (161.925 MHz) and uses the identification signal GD in morse.

Turtle Head tide gauge broadcasts on VHF Channel 87 (161.975 MHz) and uses the identification signal TH in morse.

Ince Point tide gauge broadcasts on VHF Channel 88 (162.025 MHz) from Millman Hill on Thursday Island and uses the identification signal IP in morse.

Should there be insufficient water to proceed two anchorages are recommended, one off Booby Island and one off Goods Island.

For the purposes of this investigation the Ince Point Gauge is regarded as the critical gauge. Following the grounding of the MOBIL ENDEAVOUR on 24 July 1986 Commanding Officer, HMAS BETAND, was ordered to confirm that the gauge was working correctly and that it was operating from the correct datum point. This task was completed on 21 August and the gauge was found to be functioning correctly and that the datum point was also correct.

---

* HEIGHT OF TIDE — The vertical distance at any instance between sea level and chart datum.

Appendix 5

Leading Lights

Of relevance to this investigation are the East Strait Island leading lights, which when brought into transit lead between Herald and Alert Patches on a line 090°(T). The leading line shown on chart AUS 293 merges into the recommended track for the Great North East Channel.

The International Hydrographic Organization publication 'Chart Specifications of the IHO' describes Leading and Clearing Lines at section 433. At section 433.3 it states "Leading Lines shall have the part of the track which may be followed shown by a bold continuous line and the remainder (up to the rear mark) shown by a dashed or dotted line, preferably the former". The pictorial representation of leading lights and the limits are illustrated in the publication 5011 Symbols and Abbreviations used on Admiralty Charts issued by the Hydrographer Royal Navy. The significance of the dotted or pecked lines and the distinction between the variation in these lines are not detailed.

Appendix 6

Herald and Alert Patches Light Buoys

Herald Patches light buoy is an IALA 'A' Cardinal East buoy marking the Herald Patches which lie to the west of the buoy. It is a black buoy with a broad yellow band.

Alert Patches buoy was established in 1970 as a port hand lateral mark exhibiting a red flashing light, as a consequence of the grounding of the OCEANIC GRANDEUR. Two buoys were laid at this time, one on O.G. rock and the other on a ".... 5 fathom 5 feet patch which lies in the track marked by the East Strait Island Leading Lights". (From the Statement to the House of Representatives by the Hon. Ian Sinclair, MP, Minister for Shipping and Transport of 9 April 1970 on the grounding of the OCEANIC GRANDEUR.) The buoy on O.G. rock was subsequently removed when the rock was reduced and the clearance increased to 12 metre. Ships proceeding through the Prince of Wales Channel were therefore required to leave Alert Patches buoy to the north.

A 5 fathom 5 feet (10.7m) patch referred to by the Minister was based on wartime surveys. No 10.7 metre sounding was found on the line of the East Strait leads by the surveys of 1971, 1974, 1976 and 1987, but water with a general depth of 11 metres was established close north.

Between 1970 and 1984 Alert Patches buoy had a chartered position of 10° 29.85'S, 142° 21.05'E placing the buoy on or close north of the East Strait Island leading lights. There was however a tendency for the buoy to drift slightly off its position. Correspondence between the Queensland Coast and Torres Strait Pilot Service and the Department of Transport indicates that the pilots favoured the repositioning of the buoy some 200 feet (61 metres) south of its charted position. The buoy was therefore repositioned in 10° 29.9'S, 142° 21.05'E in July 1984.

On 20 November 1985 a meeting was held between the Department of Transport and the Queensland Coast and Torres Strait Pilot Service to review the navigation aids in the Great Barrier Reef Inner Route. Discussion on Alert Patches buoy was summarised in the report of the meeting:

> "Alert Patches Buoy Position (AUS 293)
>
> Pilot Service Opinion
>
> For 12.2 metre draught vessels the danger is an 11 metre patch south of Alert Patches proper. (This 12.2 metre draught needs to be borne in mind when considering dangers to be marked in many places along the TWR) [Two Way Route]. The use of coloured lighted buoys is generally not preferred due to the low intensity/short range available. These buoys rapidly lose conspicuity in poor visibility conditions. In general the white cardinal/safe water/ isolated danger marks are preferred.
>
> The preferred mark for Alert Patches is therefore an isolated danger mark on the IIm patch. This will be a group 2 character, ...

Decision

Establish an isolated danger mark in Lat 10° 29.8' S Long 142° 21'.06E on the IIm patch south of Alert Patches. Character GFI 2 in 8 seconds."

At the meeting of the Maritime Services Advisory Committee - Navigational Safety of 16 April 1986 (made up of members from the shipping industry and the Department), representatives from the Queensland Coast and Torres Strait Pilot Service, and the Marine Board of Queensland, confirmed the report and the Committee endorsed the decision to relocate the buoy without discussion. The buoy was repositioned in early November 1986 and the change promulgated by Australian Notice to Mariners 633/86.

Between 1970 and November 1986 ships navigating in the area would therefore have not passed over or immediately adjacent to the position of the port hand buoy, or remained on the line of East Strait Island leading lights in the immediate area of the buoy. The area would have been left to the north of ships using the area.

Appendix 7

Meteorological effects

Easterly winds with velocities exceeding 25 knots produce positive surges (i.e. higher sea levels) at Frederick Point and Twin Island, and negative surges (lower sea levels) at Turtle Head, Goods Island and Booby Island. Westerly winds have the reverse effect. Winds with east-west components of less than 25 knots have a negligible effect.

The highest recorded surge in a 14-month period increased the height of sea level at Booby Island by 74 centimetres. At the time a low of 988.8 mbs was situated in the vicinity of Cooktown, giving rise to strong westerly winds in Torres Strait.

At Booby Island the largest recorded negative surge in the 14-month period was -40 centimetres. This surge, which occurred during a period of calm weather, was unexplained in terms of prevailing meteorological conditions.