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INTRODUCTION

On 26 April 1986 at 1735 hours local time the Indian flag bulk carrier Jhansi Ki Rani of 42141 gross tonnes, on a passage from Newcastle, Australia to Higashie Harima, Japan, ran aground on Frederick Reef in position 21° 01.5'S 154° 22'E.

At the time of the investigation on 2 May 1986 there had been no injury to any person, the ship was still aground and a salvage team was onboard with a tug standing by. Preparations were underway to attempt to refloat the vessel.

A minor quantity of oil pollution was sighted after the grounding. This pollution was apparently the result of the forward oil fuel deep tank which held 1 tonne of fuel oil, being holed on grounding.

All other fuel tanks were situated aft and were intact at the time of the investigation. The danger of further pollution was negligible.

AUTHORITY TO CONDUCT INVESTIGATION

On 29 April 1986 Jeremy Stephen Price, an officer of the Federal Department of Transport, was appointed under sub section 377A(l) of the Navigation Act 1912 to make a preliminary investigation into the circumstances of the grounding of the M.V. Jhansi Ki Rani on Frederick Reef 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

The investigation was carried out onboard the M.V. Jhansi Ki Rani at Frederick Reef and the following persons were interviewed:

Captain Shahid Hasan	Master
Luke Magno Dias	Chief Officer
Parimal Bikas Ray	Chief Engineer

Signed statements were also taken from :-

Anuj Kumar Malhotra	Second Officer
Narayanan Ranganathan Iyer	Third Officer
Ranchhodbhai Ramjibhai Tandel	Quartermaster
Yerramilli Narasinga Rao	Second Engineer

DETAILS OF M.V. JHANSI KI RANI

Official Number	.	1549
Port of Registry	:	Bombay
Nationality	:	Indian
Owners	:	The Shipping Corporation of India Ltd Bombay
Builders/Date	:	Lithgows, Glasgow 1974
Ship Type	:	Bulk Carrier
Main Engine	:	Diesel - 13600 BHP
Gross Tonnage	:	42141.49
Nett Tonnage	.	31259.33
Length		245.364m
Breadth	.	32.258m
Depth	:	18.745m
Summer Draft	:	13.828m

Certificates

Cargo Ship Safety Equipment	Issued by Korean Government on 21 June 1984 Valid until 20 June 1986
Cargo Ship Safety Radiotelegraphy	Issued by Japanese Government on 9 February 1985 Valid until 8 February 1986

This Certificate was extended in Mobile USA for 5 months

Loadline	Issued by Lloyds, London, 15 August 1985 Valid until 22 June 1989 Annual Endorsement - Korea 7 July 1985
Safety Construction Certificate	Issued by Indian Government 3 September 1984 Valid until 22 June 1989 Annual Endorsement - Korea 7 July 1985

SEQUENCE OF EVENTS

(i) Leading up to the Grounding

On 23 April 1986 the Jhansi Ki Rani left Newcastle with 74228 tonnes of coal onboard bound for Japan. The route for the voyage had been planned and plotted by the Second Officer, approved by the Master and was to take the vessel 10 miles east of Frederick Reef. The vessels service speed for a loaded passage was 11.5 knots, the draft forward was 13.6m and aft 13.7m.

At 0040 hours local time on the 25 April 1986, the vessel was off Cape Byron and set a course of 005O, which was the course to take the vessel directly to the next alter course position to the east of Frederick Reef.

The following are extracts from the vessels Deck Log, Bridge note book and charts. Explanatory notes are in brackets;

25.0040 Cape Byron brg 273° X 10'
a/c to 007° T&G allowing 2° set to make good course 005°

25.0830 27° 13'S 153° 59.8'E
a/c to 003° T&G (ship was to the east of the course line).

25.0900 27° 06' S 154° 00.5'E
(last position obtained by radar off Cape Moreton).

25.1200 Meridian Passage 26° 37.8'S 154° 08'E
Av Sp over 24 hrs. 10.58kts
a/c 000° T (V/L to the east of the course line).

25.1736 Star Fix 25° 39'S 154° 10'E
Av Sp since 0900 l0.llkts.

25.2000 DR Position 25° 14.8'S 154° 10'E
a/c 005° T&G (V/L should have been back onto the original course line).

26.0800 Solar P/L 152° /332° passing through D.R.
23° 09'S 154° 23'E.

The last fix obtained prior to running aground at 1735 hours on 26 April 1986 was the stellar fix obtained at 1736 hours on 25 April 1986. The Chief Officer, Second Officer and Third Officer stated that they endeavoured to obtain an astronomical fix in the normal course of their duties, but due to the overcast skies were unable to do so. The Third Officer did obtain one solar position line at 0800 hours on 26 April 1986, but a further sight could not be obtained.

The ship was equipped with two 3 cm radars, one of which had been in constant use since 0900 hours on the morning of the day of grounding.

The vessel was operating in automatic pilot from the gyro compass. The Master stated that he considered that there was no gyro error.

Other navigational aids consisted of a Decca Navigator and a Loran C Navigator, but these aids cannot be utilized in this area. A Radio Direction Finder was apparently used to try and obtain a position line, but the available stations were out of range. The vessel was also fitted with an echo sounder which was not working.

Dead reckoning positions were run up at 10.5 knots on a course of 005° T. The Master and Second Officer considered that 10.5 knots was a reasonable speed to use when the following points were taken into consideration:-

'Previous days run was at 10.1 knots.
Charts and Sailing directions indicated a southerly current,
at about 1 to 1.5 kts., could be expected
The wind was between NE and NW throughout the period.'

Using that speed, the Master did not expect to pick up the Frederick Reef light tower on radar before 1800 hours, when he considered that the light tower should have been 22 to 25 miles away. (Frederick Reef has a light tower situated towards the north east of the reef. The light has a nominal range of 11 miles and is at an elevation of 33 m). During the south bound passage in

good weather conditions, the light tower had been picked up on radar at 25 miles.

During the Second Officer's watch, the wind was NE'ly force 4 with drizzle and frequent heavy rain showers. By the time the Chief Officer came on watch at 1600 hours the drizzle had become continuous and the rain showers reduced the visibility from 8-10 kms between showers to 2-3 kms. (4-5 miles to l-l.5 miles).

At 1515 hours, the Second Officer had noted an echo on the radar on the vessel's port quarter at 17.5 miles, this echo painted on the screen throughout the Chief Officer's watch, until the radar display range was reduced at approximately 1715 hours. The echo on the port quarter was in fact the M.V. Fort Resolution, which later stood by the grounded vessel.

The Chief Officer, when coming on watch, calculated that he should pick up the Frederick Reef Light on radar at about 1820 hours, when the light should have been 22 miles away. He maintained a visual and radar watch assisted by a lookout on the starboard bridge wing.

At 1715 hours, an echo was picked up on the starboard bow at 9 miles and the radar display switched to the 12 mile range. The echo was indistinct and obscured by rain clutter (it was apparently raining at this time) and then failed to show at all. The Chief Officer scanned the horizon with his binoculars and instructed the lookout to watch for a ship on the starboard bow.

The Chief Officer stated that at this time he did not even suspect that the echo on his starboard bow could have been the reef, as he did not expect to see it for at least another hour and he expected to pick it up on the radar at 22 miles. However this echo was entered in the radar log, at some time after the grounding, as the Frederick Reef Light tower.

At about 1715 hours the Chief Engineer came onto the bridge in order to ascertain if the emergency fire pump was being tested by checking the exhaust located in the fore part of the ship. The Chief Engineer stated that he saw that the Chief Officer was busy and did not therefore talk to him.

At 1720 hours the target reappeared on the radar at 7 miles, and the Chief Officer again went to look for it with his binoculars.

At approximately 1725 hours, the Captain came onto the bridge to satisfy himself that the voyage was proceeding as planned and because he expected to pick up the reef in the next half hour. The Chief Officer told him that there was one target on the radar and turned to scan the horizon. The Chief Engineer left the bridge. Almost immediately the Chief Officer told the Master that he could see a white line close ahead. Both the Chief Officer and the lookout put this time at 1730 hours. The lookout was on his way into the wheelhouse to report the same when the Master ordered the automatic helm to be altered into manual steering and to put the helm hard to port. This was done, but the vessel had only swung through 13° before she ran aground heading 352° in position 21° 01.5 S 154° 22'E on the southern edge of the reef, 5.7 miles from the light tower.

(ii) After the grounding (on deck)

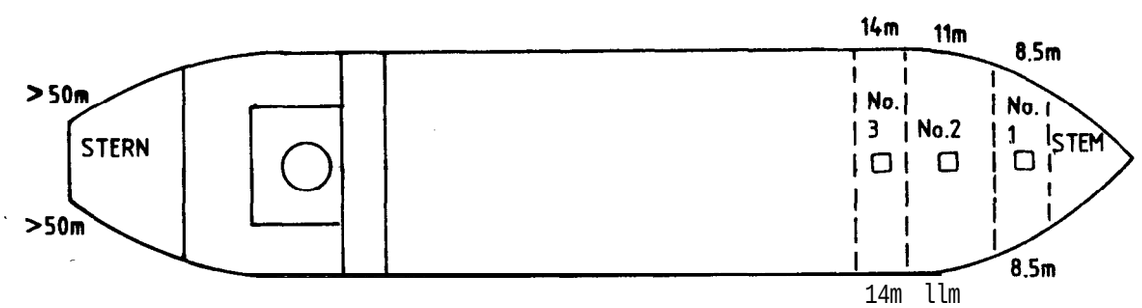
At 1735 hours, when the vessel went aground the engines were still going full ahead, as there had been no time to stop them. On running aground the engines were stopped and at 1736 hours were put full astern. Between 1736 hours and 1913 hours the engines were used to try and bring the vessel off the reef but by 1913 hours, all efforts proving fruitless, the attempts ceased.

At the time of the grounding, the vessel's head was 352°. The vessel continuously swung with the bow aground until about 0500 hours on 29 April 1986 when the heading was 041.5°. The vessel remained on this heading until the time of this preliminary investigation on 2 May 1986.

The Master told the Chief Officer to sound all tanks and by 1745 hours it was discovered that the following tanks were breached

Fore Peak Tank
Deep Tank Port and Starboard (prior to the grounding this tank held 1 Tonne of Fuel Oil)
No. 1 Double Bottom Port and Starboard
No. 1 bilges indicating that water was entering No. 1 hold.

At 1830 hours, the water depth around the ship was sounded with the results shown below. This indicated that the vessel was hard aground from the stem to the after end of No. 2 Hatch.



The following are extracts taken from the Bridge Note Book:

'27/0400 - all soundings the same
27/1415 - No. 2 DB (S) started to take water
27/2000 - No. 2 Hold (P&S) bilges started to take water
No. 3 Hold (P&S) bilges started to take water
2712025 - No. 2 DB (P) filled with ballast
27/2200 - No. 3 DB (P) filled with ballast'

From 2000 hours on 27 April bilges in Nos. 2 and 3 holds were pumped whenever the bilge pumps were not being used for the engine room.

The vessel continued to "work" on the reef, with the bow remaining hard aground. At the time of the investigation, the following compartments were reported to be breached:

'Fore Peak
Deep tank (P&S)
Emergency Fire Pump space forward
No. 1 Hold
No. 1 DB (P&S)
No. 2 DB (S)
No. 2 DB (P) is suspect
No. 2 Hold taking water gradually
No. 3 Hold taking water gradually
The Duct Keel and Engine Room Cofferdam.'

The Master had broadcast an Urgency Message at 1753 hours on 26 April 1986 and upgraded to a Distress Message at 1914 hours, because the engine room bilges were flooding and the ships pumps were not coping with the ingress of water. The crew were kept standing by the life boats at the embarkation deck until the water level in the engine room bilges was controlled.

Two vessels, the M.V. "Caribbean Confidence" and M.V. "Fort Resolution" stood by the Jhansi Ki Rani. The "Caribbean Confidence" left at about 2200 hours on 27 April 1986 and the "Fort Resolution" departed when the Federal Department of Transport's navigation aid servicing vessel M.V. "Cape Moreton" arrived on

the morning of 28 April 1986. The "Cape Moreton" stood by providing assistance to the vessel and salvage personnel and was still there on 2 May 1986.

The salvage personnel first arrived on board at 1115 hours on 29 April 1986 and began to prepare to attempt refloat the vessel.

(iii) After the grounding (in the engine room)

The Chief Engineer stated that he was in his cabin at the time of the grounding. On reaching the engine room he was informed by the Master that the vessel was aground and that he should sound the engine room tanks. Moments later he was informed by the 5th Engineer that the cofferdam (see Attachment D) was full of water and the water was flooding the engine room bilges via the cofferdam sounding pipes.

The after sounding pipe was capped and the forward pipe plugged with a wooden plug.

With the capping of the sounding pipes, it was then noted that water was pouring through the duct keel vent trunking via the exhaust fan blowers, situated in the engine room, on the cylinder head platform.

The arrangement of the duct keel and cofferdam is shown at "Attachment D". On grounding, the duct keel had apparently been breached, allowing water into the engine room cofferdam. There are no watertight bulkheads, doors or plates between the duct keel and cofferdam.

Initially the following pumps were used to control the ingress of water:-

a) Main bilge pump - 250m3/HR
b) Oily bilge separator pump - 25m3/HR
c) Port fire and general service pump - 175m3/HR.

The starboard fire/general service pump could not be used, as it had been dismantled on the previous day for servicing. A short time later the port fire and general service pump had to be stopped, as a bearing was overheating.

The water in the engine room bilges reached the floor plates, putting various main engine auxiliary lubricating pumps, feed pumps etc. out of service. The after main engine circulating pump ($700m^3$/HR had been started and two Wilden portable pumps were also employed in pumping the bilges.

By 1200 hours on 27 April 1986, the water level was reported to be under control and until 0742 hours on 28 April 1986 the level was apparently falling gradually. During this time, forward tanks were ballasted and hold bilges pumped when possible, the engineers were also endeavouring to recommission one of the fire and general service pumps.

At 0742 hours on 28 April 1986, the water level in the bilge rose again and it was found that the after port manhole cover on the cofferdam was leaking. A number of bolts were replaced and all bolts tightened in an endeavour to reduce the ingress of water. This was successful and by 2200 hours on 28 April 1986, the level in the bilges was well under control. Dismantling of the flooded electric motors was undertaken. The Chief Engineer stated that the bilge filters were continuously being cleaned.

The salvage personnel came on board at 1115 hours on 29 April 1986 and experienced more trouble with the cofferdam covers to the extent that divers had to work under water to renew bolts to tighten down the covers. On the 30 April 1986 at about 1030 hours, the crew was put on alert for abandoning ship, as the ingress of water was reported to be so large. The level was however reduced and, at the time of the investigation on 2 May 1986, the engine room bilges were almost dry.

OBSERVATIONS

1) The Master stated that he expected a southerly current of 1 to 1.5 kts based on previous speed, and information from the chart and Sailing Directions.

This adverse current did not eventuate. The distance from the star position at 1736 hours on to the grounding position at 1735 hours on the 26th is 277 miles, which gives the average speed over that distance of 11.54 knots, the service speed of the vessel.

The note on the chart states:-

> 'Seaward of the 100 fm line the south Subtropical Current setting West-south westward turns more southerly and becomes the East Australian coast Current which south of Lat 22° sets predominantly southward between about long. 156° E and the 100 fm line with average rates of about 3/4 and l 1/2kts. increasing from North to South. At times the current has exceeded 21/2knots.'

In the Australia Pilot Volume 3, it notes that the East Australian Current sets southerly with the strongest flow following the 100 fm line, its width varies from 20 to 60 miles.

> 'The W boundary lies close to the mainland, but there is no well-defined E edge. The predominant direction is S and its constancy is high especially in the area between 25° S and 30° S.... Between the E flank of the East Australian Current and 160° E the flow of water shows considerable variability both from place to place and from month to month..... In April the SW-going sets occupy most of the area but, N of about 23° S the flow is more N.W. as it crosses the meridian of 160° E.'

2) The echo sounder was not working and had not worked since October 1985. In this instance, however, the echo sounder would have been of little use as the soundings reduce so rapidly onto the reef that no warning of the approaching reef could have been obtained from it.

The Master stated that all efforts had been made to repair the echo sounder, but apparently major repairs were required and were planned for drydocking in June 1986.

3) There is some conflicting evidence between the Chief Officer's, Chief Engineer's, and Captain's statements.

The Chief Officer stated that the Chief Engineer was on the bridge for sometime prior to the grounding but didn't know when he came onto, or left, the bridge, or what he came there for. He did not engage in conversation with the Chief Engineer, but may have talked to him in passing.

The Chief Engineer stated that he went to the bridge at 1715 hours but did not disturb the Chief Officer because he saw that he was busy. He left the bridge after 2-3 minutes.

The Master on entering the bridge at 1725 hours saw the Chief Officer talking to the Chief Engineer.

4) From these statements, the following is considered to be the sequence of events immediately prior to the grounding:

1715 hours	Chief Officer picked up target on radar on starboard bow at about 9 miles, but lost it again almost immediately. Chief Engineer comes to bridge.
1720 hours	Radar located target at 7 miles and Chief Officer went to look for the target with binoculars.
1725 hours	Master enters bridge, Chief Engineer leaves bridge. The Master described the time interval between his arrival on the bridge and the sighting of the broken water as "just a few moments". Therefore the period may have occupied any time from five minutes to a "few moments".

1730 hours Chief Officer and lookout first see line of white water ahead, wheel put hard to port.

The times and distances given in the statements are inconsistent with the average speed of 11.5 knots as recorded from the ship's last established position of 1736 hours on 25 April and the time of grounding, and can only be taken as an indication of the developing situation subsequent to 1700 hours. This assertion is based on the fact that the ship grounded with Frederick Reef light bearing 02° x 5.7 miles and on the assumption that the reported radar targets of 1715 hours and 1720 hours were in fact echo returns of the light structure (as reported in radar log).

Further the stated time between the Master's order to put the wheel over and the time of grounding, is not consistent with known manoeuvring characteristics of similar ships and certainly not with a change in course of only 13 degrees. It is therefore reasonable to assume that the time between putting the rudder hard to port and the grounding was considerably shorter than the five minutes assumed by the Master.

5) The engines were put full astern at 1736 hours, without a proper assessment of the damage to the hull being made. The damage should have been ascertained prior to any attempt to refloat the vessel.

6) From the Chief Engineer's and Second Engineer's statements, it would appear that the cofferdam sounding pipe caps were not secured in position at the time of the grounding.

7) From the Chief Engineer's statement, it would appear that the engineers were engaged in "continuous cleaning of bilge filters". He stated that the filters were blocked mainly with rust, cleaning rags and jute that the crew had been cleaning with prior to the grounding.

8) It is apparent that the cofferdam manhole covers leaked badly. It is not clear when they started to leak. The Chief Engineer gave as possible explanations:-

that the covers and flanges were not true or were wasted.

(b) that the bolts used may have not been of sufficient strength and elongated under the pressure of water, and

(c) that the packing may have been old and brittle and given way under the pressure of water.'

He stated that, to the best of his knowledge, all of the securing bolts were in place when he checked the after port plate, when it began leaking and that he did not have time to check the other covers.

The Chief Engineer had been on the ship since 8 January 1986 but had no record of when the cofferdam was last opened up.

The vessel had a valid Safety Construction Certificate issued by the Government of India covering hull and machinery. The last survey had been carried out in Busan, Korea on 7 July 1985.

9) The starboard general service/fire pump was dismantled for maintenance.

The port G.S./fire pump when used to attempt to pump the engine bilges had to be stopped almost immediately.

CONCLUSIONS

The grounding was caused by an accumulation of factors:-

1) No definite position fixes were obtained since 1736 hours on 25/4/86.

2) Both the Master and Chief Officer showed an unseamanlike complacency in their navigational duties when approaching a hazard of this nature in the prevailing weather conditions. While the light tower is normally a good radar target in good conditions, it should have been realised that rain clutter could obscure the echo return. Slowing or stopping the vessel would have been prudent under the circumstances.

   (a) Both officers were relying on picking up the light tower at 22 miles on the radar, as this was the distance that the light tower was picked up on the way south. No consideration was given to the fact that the rain showers and drizzle could affect radar propagation, or that the tower was located on the northern tip of the reef.

   (b) Both expected to see the light at a specified time. Even when the Chief Officer picked up a target on the radar on the starboard bow he assumed it was a ship, because the light was not expected until later.

   Even though the visibility was down to 2-3 kms. (l-1.6 miles) the Chief Officer did not call the Master.

3) The Master did not properly assess the significance of the data concerning the prevailing currents, particularly as published in the sailing directions, Australia Pilot Volume 3.

4) The Master's assessment of the current and ships expected speed was wrong. The vessel was apparently set to the West while the speed made good was hardly affected. The Master and officers seriously underestimated the speed of the vessel. Given that the last definite position of the vessel was obtained within 50 miles of the coast, it

would have been reasonable to assume that any adverse current experienced then, may have dissipated when the vessel was virtually in the open ocean. Had the dead reckoning positions been run up at the vessel's service speed, the solar position line obtained at 0800 hours on the 26th April would have indicated that the vessel was to the west of her intended course.

5) The degree to which the concentration of the Chief Officer was affected by the presence of the Chief Engineer is not known.

6) Although it is realized that the deck log and bridge note book would have been written up some time after the grounding, there is still doubt over the times and distances given for the interval between first visually sighting the reef and running aground.

While these anomalies are not considered significant in relation to the cause of the grounding, it does call into question the accuracy of the officers statements as it has been established that the ship's average speed for the previous day had been 11.54 knots.

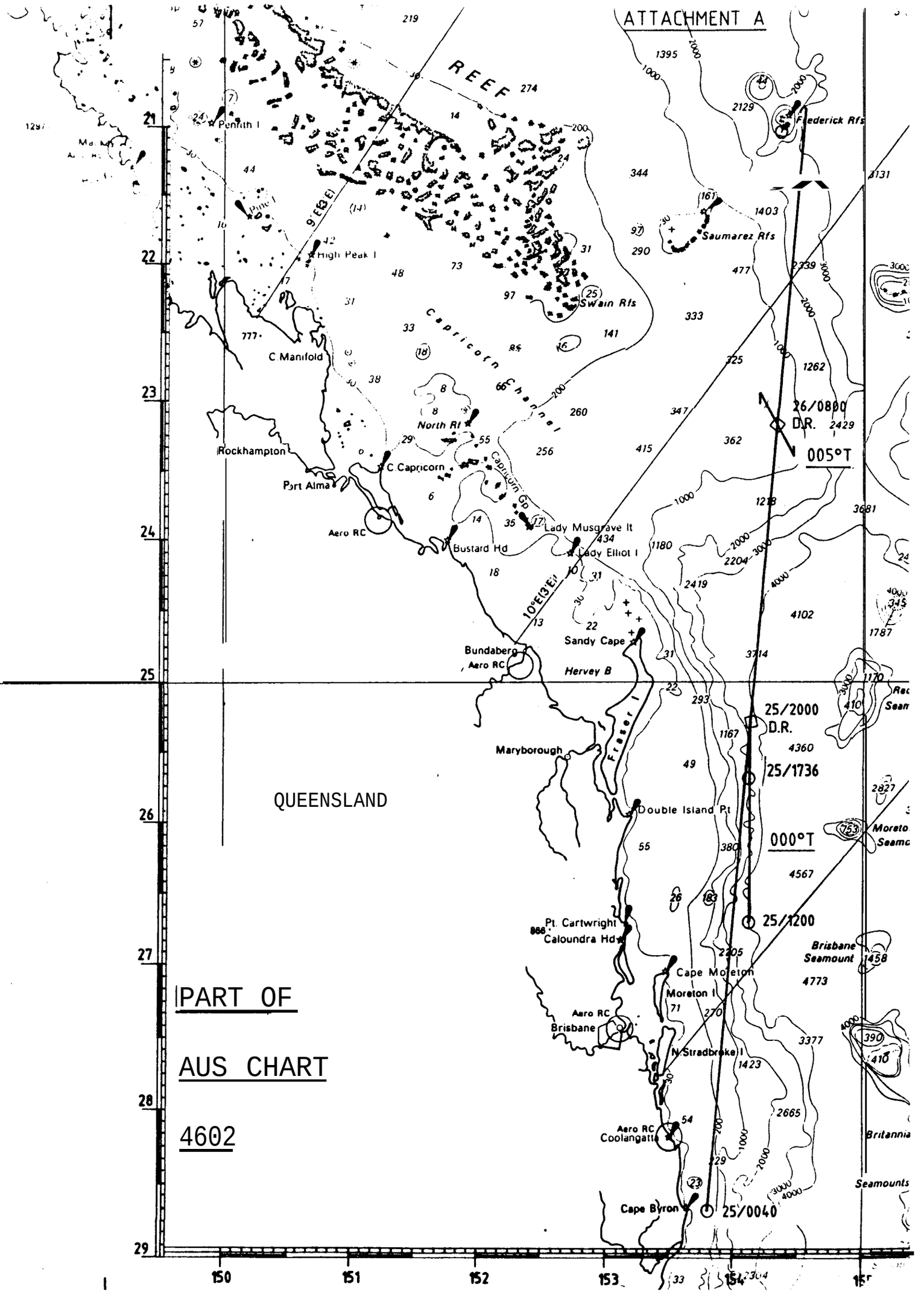
7) The engines were run astern intermittently between 1736 hours and 1913 hours, without a full assessment of the damage to the vessel being made. This action may have increased the damage to the hull and, in the worst case, if the ship had come off the reef, it may have sunk immediately.

Subsequent to the grounding the seriousness of the situation and potential danger to the ship was compounded in that :-

8) The design of the duct keel and engine room cofferdam system as an integral unit, with no provision for subdivision, made the engine room vulnerable in the event of bottom damage. Water entered the engine room, from the duct keel and cofferdam, through sounding pipes, the duct keel venting system and leaking manhole covers.

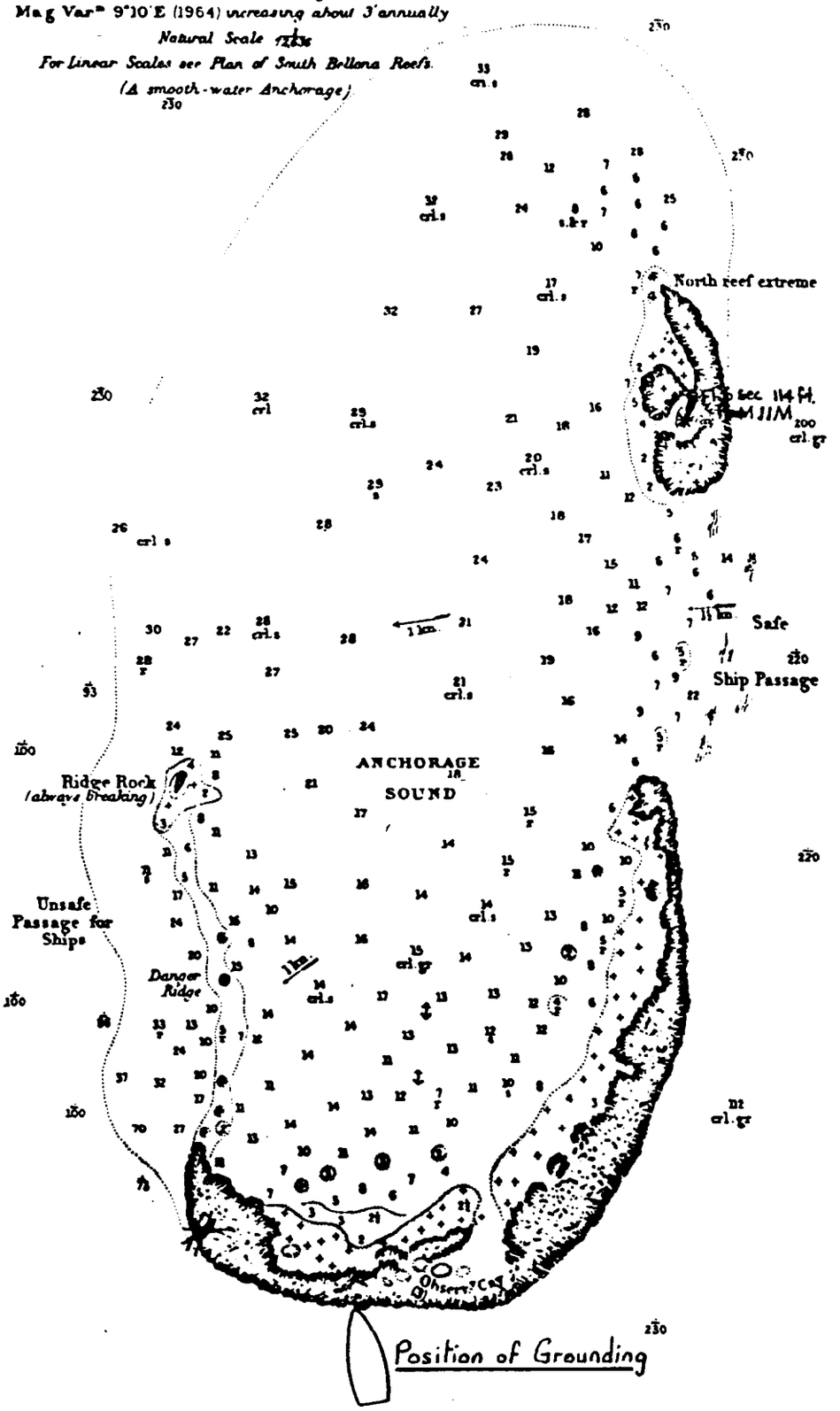
9) The cofferdam sounding pipe caps were left uncapped.

10) There would appear to have been an excessive amount of rags and jute in the engine room bilges which caused the pumps to become blocked.


ATTACHMENT A
REEF
Capricorn Channel
Penrith I
High Peak I
Swain Rfs
Saumarez Rfs
Frederick Rfs
C Manifold
Rockhampton
Port Alma
C Capricorn
North Rf
Lady Musgrave It
Lady Elliot I
Bustard Hd
Aero RC
Bundaberg
Aero RC
Sandy Cape
Hervey B
Fraser I
Maryborough
Double Island Pt
Pt. Cartwright
Caloundra Hd
Cape Moreton
Moreton I
Brisbane
Aero RC
N Stradbroke I
Aero RC
Coolangatta
Cape Byron
Brisbane Seamount
Britannia Seamounts
26/0800
D.R.
005°T
25/2000
D.R.
25/1736
000°T
25/1200
25/0040
QUEENSLAND
PART OF
AUS CHART
4602
150
151
152
153
154

FREDERICK REEF

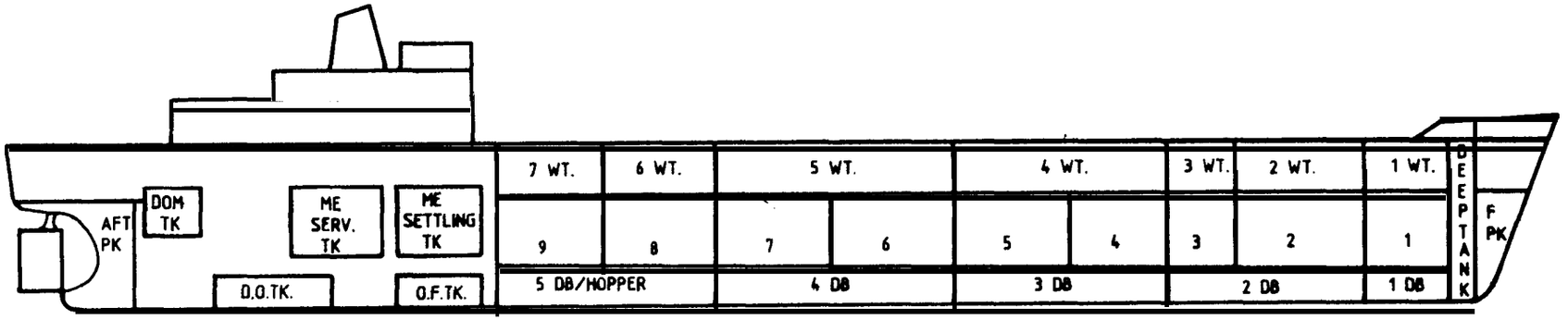
Observ.ᵗ Cav. Lat 21°1 40'S. Long 154°23'26"E.
Mag Var.ⁿ 9°10'E (1964) increasing about 3' annually
Natural Scale 1/22,36
For Linear Scales see Plan of South Bellona Reefs.
(A smooth-water Anchorage)



Cables 10 5 0 1 2 3 4 Sea Miles
(6080 ft.)
Scale of Longitude
Seconds 60' 30' 0 1 2 3 Minutes
Feet 1000 0 6000 12000 18000 24000 Feet
Metres 1000 500 0 1000 2000 3000 4000 5000 Metres

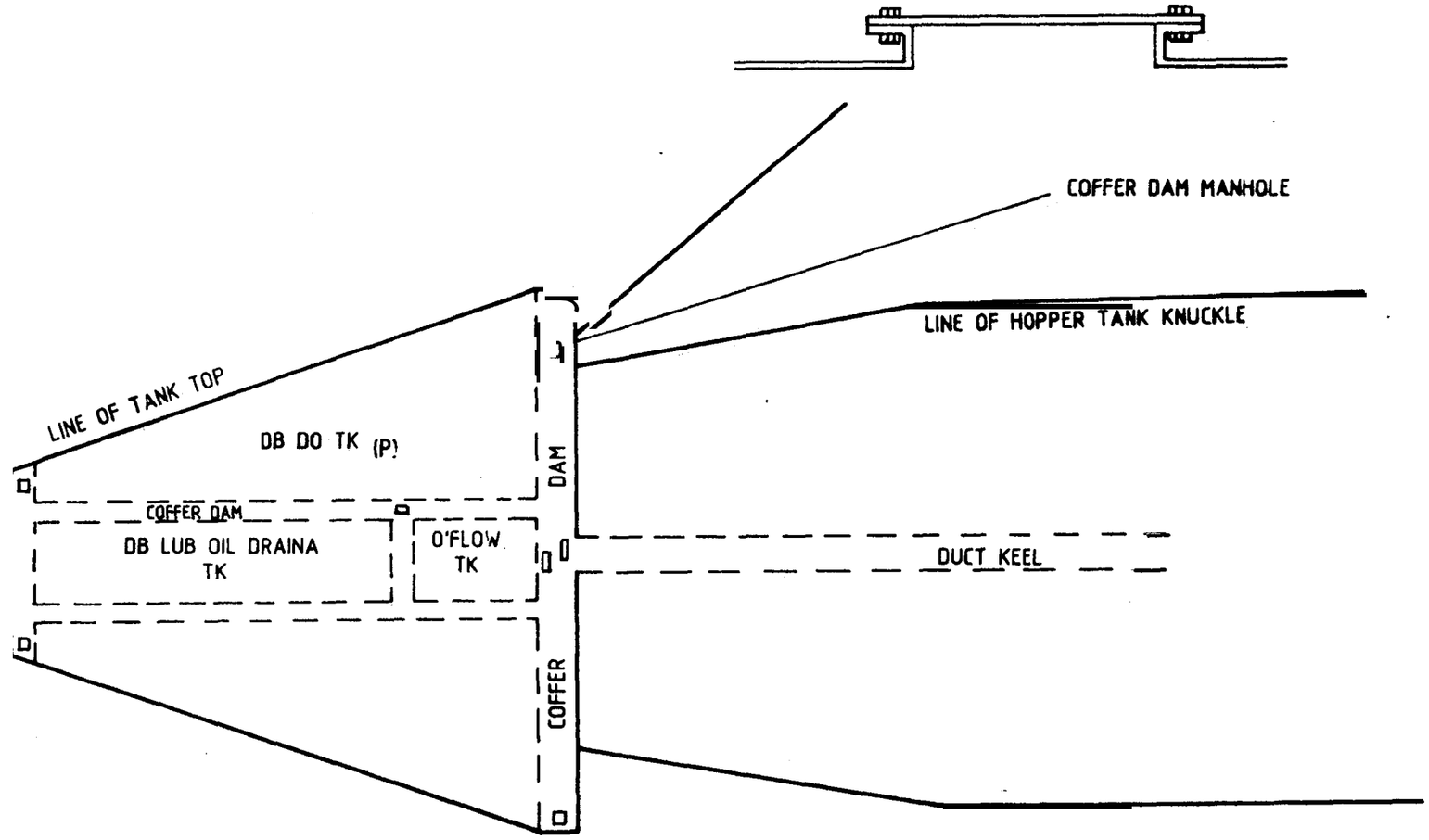
PART OF CHART BA 349

ARRANGEMENT OF SHIP HOLDS AND TANKS



ATTACHMENT C

ARRANGEMENT OF COFFER DAM



ATTACHMENT D