Report 98-212

Restricted-limit passenger catamaran *Scat Cat*

foundering

Lake Rotorua

24 September 1998

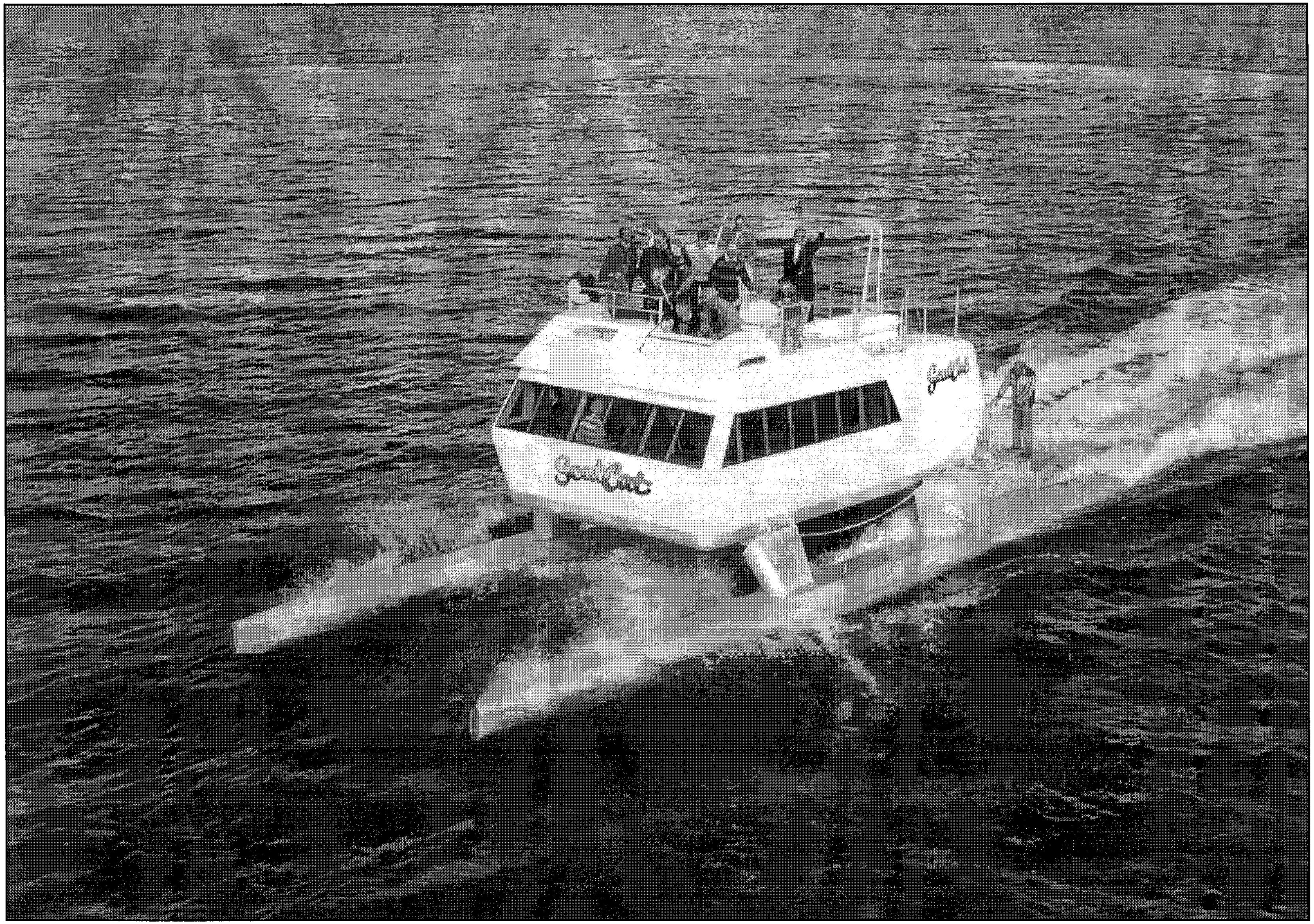
Abstract

On Thursday, 24 September 1998, at about 1710, the restricted-limit passenger catamaran *Scat Cat* foundered off Mokoia Island in Lake Rotorua. The vessel had been on a one-hour sight-seeing tour with two crew and seven passengers, including four children, on board. The passengers and crew abandoned the vessel and were rescued from lifefloats by two speedboats, one belonging to the owner of *Scat Cat* and the other to a colleague. One three-year-old passenger was detained in hospital overnight for observation for hypothermia. There were no other injuries. *Scat Cat* was approved to carry up to 50 passengers.

Safety issues identified included:

- the potential for damage to the vessel's propulsion equipment while operating in shallow water
- the potential for wear damage to the inside of stern tubes and propeller rope guards with small clearance tolerance around the propeller shafts
- the lack of watertight integrity between sections of the vessels pontoons
- lack of follow-up inspection of Corrective Action Repair requirements by the safe ship management provider.

Repairs and modifications were made to the vessel to eliminate specific safety issues. Recommendations were made to the Manager of Marine and Industrial Safe Ship Management Services and to the Director of Maritime Safety to address the safe ship management safety issue which has widespread application to maritime safety.



Passenger catamaran *Scat Cat* on Lake Rotorua

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Glossary of abbreviations and terms

aft	rear of the vessel
bilge	space for the collection of surplus liquid
bulkhead	nautical term for wall
command	take over-all responsibility for the vessel
CAR	Corrective Action Repair
dog	cleat or device for securing water-tight openings
draught	depth of the vessel in the water
EPIRB	emergency position indicating radio beacon
frame	rigid profile providing strength to the hull of a vessel
inclining experiment	deliberate listing of a vessel to determine its stability
knot	nautical mile per hour
kW	kilowatt
list	angle of tilt caused by internal distribution of weights
longitudinal	pertaining to length. Applied to any fore and aft member of a ship structure
m	metres
mm	millimetres
MSA	Maritime Safety Authority
rpm	revolutions per minute
statical stability	measure of a vessel's stability in still water
trim	difference between the forward and aft draughts of a floating vessel
VHF	very high frequency

Transport Accident Investigation Commission

Marine Accident Report 98-212

Vessel particulars:

Type:	Restricted-limit passenger catamaran
Port of Registry:	Tauranga
Limits:	Lake Rotorua, Lake Rotoiti and Ohau Channel
Allowable passengers:	50
Length (overall):	16.65 m
Breadth:	5.71 m
Tonnage (Gross):	27 t
Tonnage (Net):	20 t
Construction:	Aluminium and Glass Reinforced Plastic
Built:	Auckland in 1991
Propulsion:	Two CT6 Cummins Marine diesel engines, each of 186 kW and driving through a TwinDisc MG 5061 reduction gearbox to a three-bladed fixed-pitch propeller
Normal operating speed:	18 knots

Location:	Lake Rotorua	
Date and time:	Thursday, 24 September 1998 at about 1710[1]	
Persons on board:	Crew:	2
	Passengers:	7
Injuries:	Crew:	nil
	Passengers:	1 minor
Nature of Damage:	Port propeller shaft rope guard torn free Port stern tube entry partially torn from hull Both engine compartments flooded Water damage to cabin fittings	
Investigator-in-Charge:	Captain John Mockett	

[1] All times in this report are in NZST (UTC + 12 hours) and expressed in the 24 hour mode

1. Factual Information

1.1 History of the trip

1.1.1 The passenger cruise vessel *Scat Cat* left the main jetty on Rotorua lakefront at about 1600 on Thursday, 24 September 1998 for a one-hour sight-seeing trip around Mokoia Island (see Figure 1). On board were the skipper, one crew member and seven passengers, including four children.

1.1.2 The skipper negotiated the narrow shallow channel away from the jetty at slow speed and then motored out to Mokoia Island at about 17 knots. The passage to the island took about 20 minutes.

1.1.3 The skipper reduced speed to about eight knots and completed a circuit of the island, giving a commentary on places of interest and a history of the area.

1.1.4 The skipper recalled that he completed the circuit at 1642, which he considered to be about the right timing to get his passengers back to the jetty for 1700.

1.1.5 The skipper applied power to the engines to build up speed for the return trip. He expected that for the control settings that he applied both engines would produce about 1700 rpm. The starboard engine responded to that level but the port engine only produced about 1400 rpm. He pulled the throttles right back and then tried again but the result was the same.

1.1.6 At this time neither the skipper nor the crew member observed anything untoward with the vessel, so the skipper's initial presumption was that there was a mechanical problem. He had experienced the same symptoms several times previously when the throttle control cables had slipped.

1.1.7 The skipper stopped both engines and instructed the crew member to bring the tool kit to the cockpit. Meanwhile, at about 1645, he radioed the wharf office staff to inform them that he had engine problems and would be late returning. He said that it was his intention to investigate and rectify what he thought was a slipped throttle control cable while still out on the lake, rather than proceed to the jetty.

1.1.8 The skipper, assisted by the crew member, removed the front panel of the engine control station to inspect the cable connections. He found that there was nothing wrong at that end and therefore suspected that the cable connection at the engine end had slipped. He replaced the panel and was about to proceed to the engine space when he noticed that the vessel had taken a port list and that the forward section of the starboard pontoon was lifting out of the water.

1.1.9 Approximately 15 minutes had elapsed while the skipper looked for a mechanical fault. He looked aft and realised that the aft section of the port pontoon was underwater. The skipper went to a machinery room located at the port aft end of the cabin and turned the main bilge pump operating switch on. On his way back to the cockpit he instructed the crew member to move the passengers out from the cabin and on to the afterdeck, and to clear the lifefloats ready for use.

1.1.10 Once back in the cockpit, the skipper attempted to start the port engine which drove the 230 volt generator and would have supplied power to the main bilge pump. The engine initially fired but stalled and would not restart so the main bilge pump was inoperable. A small capacity automatic bilge pump, which was battery operated, was running.

1.1.11 At about 1700 the skipper radioed the wharf office staff and informed them that the vessel was taking on water, listing to port and becoming increasingly trimmed by the stern. He asked that rescue boats be sent out to assist. He was assured by the wharf office staff that two boats would be dispatched to the scene immediately

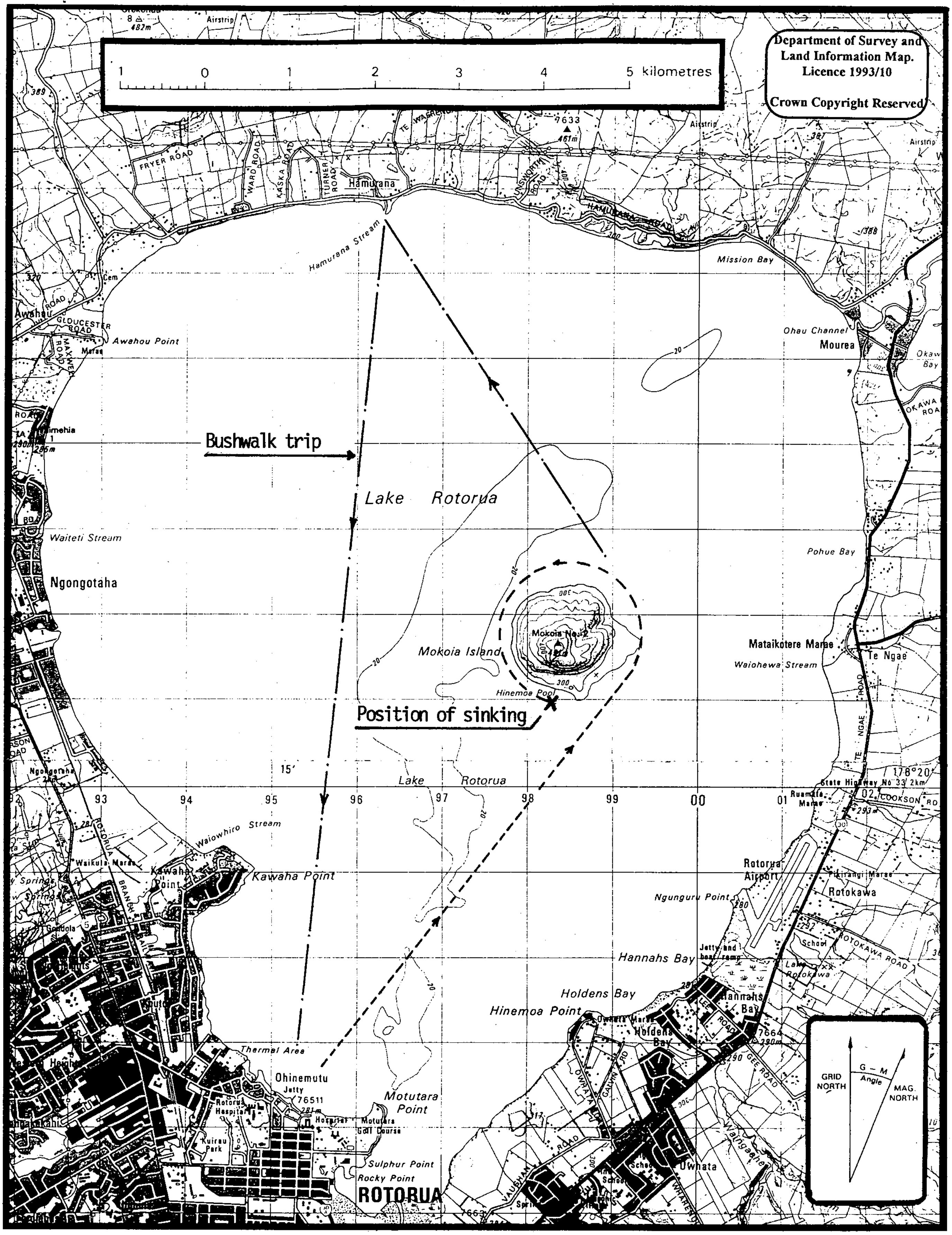


Figure 1
Map of Lake Rotorua showing routes of *Scat Cat* trips.

1.1.12 The skipper started the starboard engine and tried to steer the vessel back towards Mokoia Island with the intention of beaching in shallow water. He found that it was difficult to steer with the port list, stern trim and only the starboard engine running and decided that there would be insufficient time to reach the shallow water before the vessel sank.

1.1.13 At about 1705 the skipper ordered Abandon Ship. Knowing that rescue boats had already been called, and assuming that they had been dispatched, he did not make a Mayday call or activate the EPIRB.

1.1.14 The three available liferings were utilised for the older children. Two 16-man lifefloats were launched and the crew member entered the water to assist one adult passenger and the youngest child on to one lifefloat. The skipper helped the other two adults on to the other lifefloat and handed the next youngest child to them. The two oldest children were in the water in liferings before being pulled up onto the floats. The skipper entered the water and clung to the side of one float.

1.1.15 With the vessel settling quickly by the stern, the aft section of the starboard pontoon soon began to submerge and the vessel sank rapidly and settled to the bottom of the lake with the two forward sections of the pontoons rising vertically out of the water. The passenger cabin was almost totally submerged.

1.1.16 On receiving the skipper's request for assistance at about 1700, the wharf office staff alerted the owner who launched his speedboat *Helkaris,* and proceeded to assist. The office staff also alerted a colleague whose speedboat was already afloat close by and he too proceeded immediately to the scene.

1.1.17 The colleague arrived at the scene at about 1715 followed shortly by the owner. The two boats picked up the people from the floats and the skipper from the water and proceeded back to shore.

1.1.18 Although there were no apparent injuries, the owner requested the office staff to call an ambulance to meet the boats. There were no injuries, apart from the youngest child, who, with temperature of only 32 degrees centigrade, was kept in hospital overnight for observation.

1.1.19 The owner returned to the sunken vessel and attached a light. At that stage the intention was to inspect the wreck using divers the next day and commence the salvage.

1.2 Previous trip information.

1.2.1 On the day of the accident, the *Scat Cat* had been made ready for cruising at 0900 and moved from its mooring to the jetty by the skipper. Cruises were advertised to start at 1000, 1100, 1300 1400 and 1530. The majority of passengers did not make bookings but purchased tickets at the wharf office. On the day of the sinking, a party of 18 had booked for the 1400 sailing which was to include a bushwalk at Hamurana. (See Figure 1).

1.2.2 There were no customers for the earlier trips, so the 1400 sailing was the first of the day. Two casual customers joined the booked party, making a total of 20 passengers. The trip went from the main jetty to Mokoia Island and then across to Hamurana, where the vessel was tied up to a jetty. The skipper remained with the vessel while the crew member took the passengers on a 45-minute bushwalk after which they reboarded for the return trip to Rotorua. Neither the skipper nor the crew member noticed anything untoward during the trip.

1.2.3 The *Scat Cat* arrived back at the main jetty at about 1600 and the 20 passengers disembarked. The family group of seven passengers who sailed on the accident trip was waiting on the wharf and as soon as they boarded, the skipper proceeded on the trip to Mokoia Island.

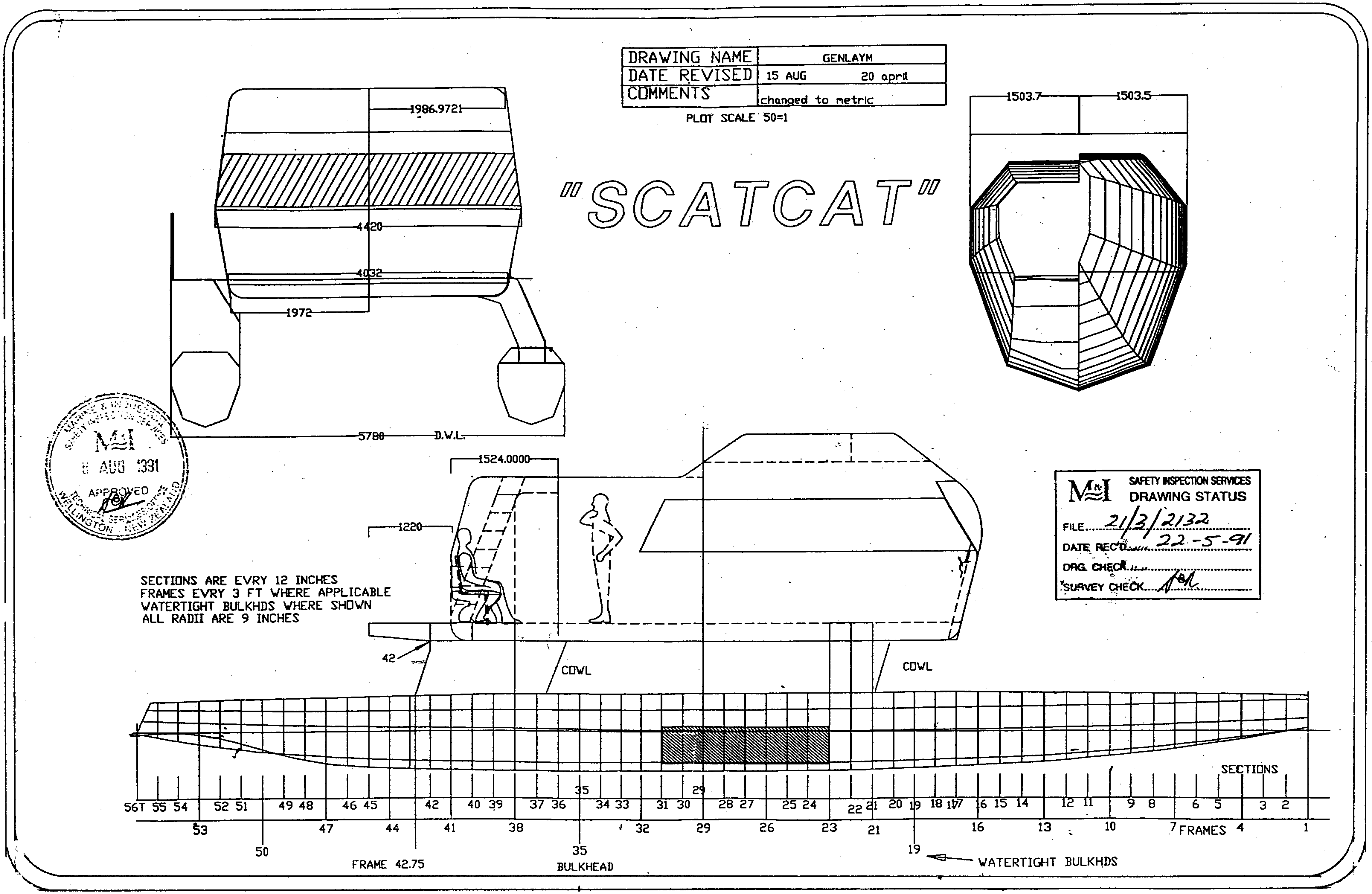


Figure 2
Line plan of *Scat Cat* showing general construction

1.3 Salvage information

1.3.1 *Scat Cat* was inspected by divers the day after the sinking. They found that the aft sections of both pontoons were buried in mud about one metre deep. They were unable to locate any hull damage. From plans of the vessel and the owners advice, the divers located fixing points where they intended to attach air bags to refloat the vessel. Due to the forecast of high winds that day, it was decided to prepare equipment but not commence the salvage until early on Saturday, 26 September.

1.3.2 On Saturday morning the divers attached the air bags and flotation devices to the aft end of the vessel. They were able to bring the aft end to the surface although the vessel was still trimmed heavily by the stern. *Scat Cat* was kept afloat by ensuring that the air bags remained fully inflated while it was towed to the slip at Motutara Point.

1.3.3 As *Scat Cat* approached Motutara Point the stern trim had to be reduced to allow the vessel to be hauled onto the slip. Portable pumps were put on board to pump the water from the pontoons. The starboard pontoon was pumped virtually dry but the port pontoon continued to flood, necessitating continuous pumping to maintain a suitable trim.

1.3.4 Once *Scat Cat* was on the slip, the water drained out of the port pontoon through the stern tube entry. The vessel was loaded on to a flat-bed trailer and taken to a repair facility the following morning.

1.4 Vessel information

1.4.1 The *Scat Cat* was a 16.65 m aluminium-hulled catamaran with a passenger cabin constructed of glass-reinforced plastic (GRP). The vessel was approved to carry 50 passengers. Propulsion was by two Cummins Marine diesel engines, each of 186 kW driving through a TwinDisc MG 5061 reduction gearbox to a three-bladed fixed-pitch propeller. The gearboxes fitted had a ratio of 1.15 : 1. (See Figure 2).

1.4.2 The propeller shafts were made from 44.5 mm diameter stainless steel bar. The shafts exited the pontoons through aluminium stern tubes. The stern tubes were of 65 mm outside diameter and 6 mm wall thickness giving an internal diameter of 53 mm. The propeller shafts, therefore, had a clearance of 4.25 mm within the tubes. The stern tubes projected about 250 mm outboard and 300 mm inboard of the pontoon entries. (See Figures 3 and 4).

1.4.3 For 675 mm of their length, between the outboard end of the stern tubes and water lubricated bushes in the shaft support struts, the propeller shafts were encased in rope guard tubes. These tubes were of 65 mm outside diameter and 4 mm wall thickness giving an internal diameter of 57 mm. The propeller shafts therefore had a clearance of 6.25 mm within the tubes. (See Figures 3 and 4).

1.4.4 The rope guard tube was held in place at the forward end by a heavy duty rubber sleeve connected to the outboard end of the stern tube, and at the aft end by a nylon bush between the tube and the boss of the propeller shaft strut.

1.4.5 Each of the two pontoons was divided into four sections separated by watertight bulkheads. The aft sections were 1.8 m long void spaces. The second sections were 4.3 m long and housed the engines. The third sections were 4.9 m long and housed storage tanks; fuel and water on the port side and fuel and sewage on the starboard side. The forward sections were 5.5 m long void spaces. (See Figure 2)

1.4.6 The engines were housed in the second section of each pontoon and extended up into the aft cabin support legs. Access was gained to the top of each engine through a dogged hatch on the top of the leg, or through a large removable plate on the side of the leg. A 600 mm x 200 mm air intake for each engine was on the aft end of the leg.

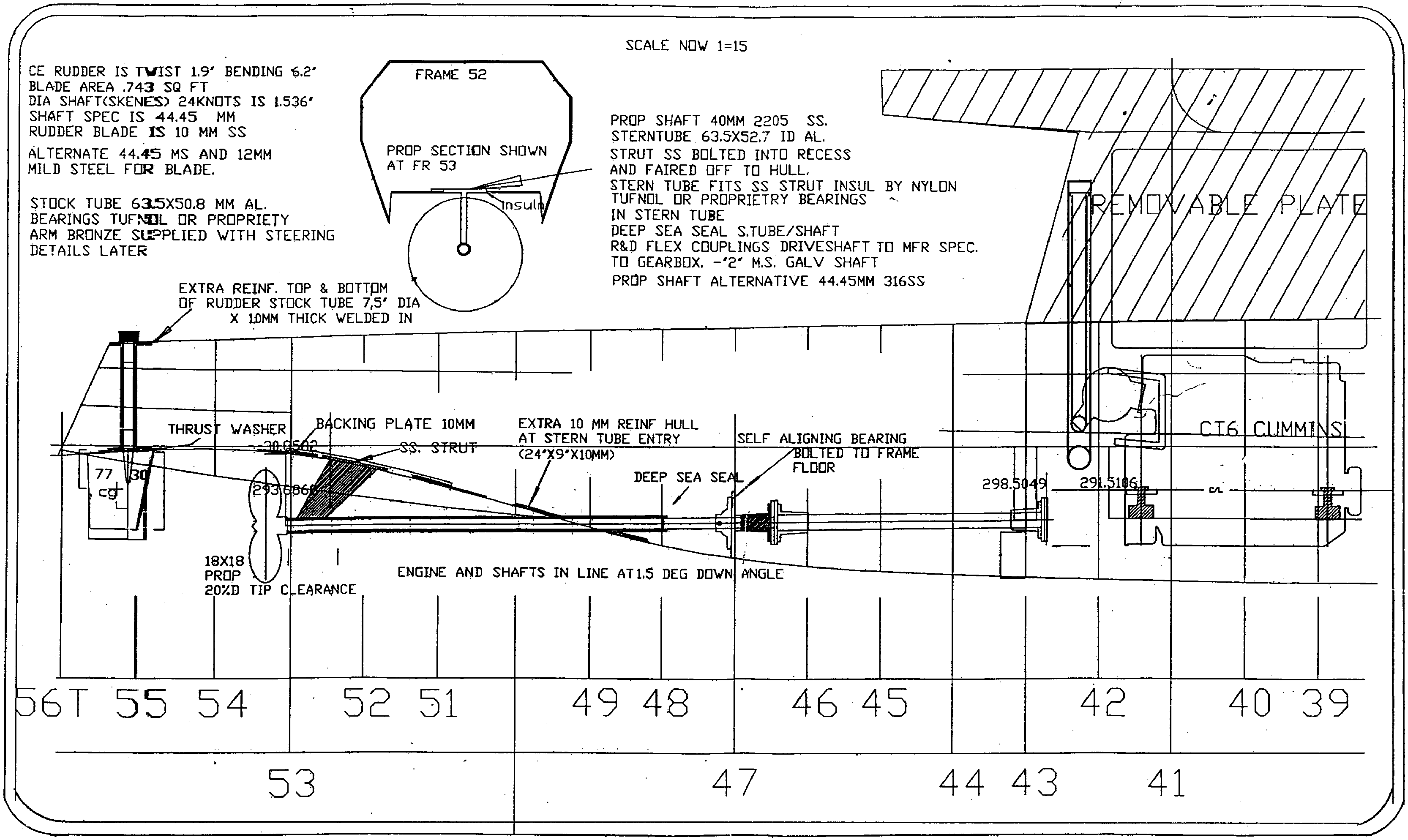


Figure 3
Line plan of *Scat Cat* showing construction in way of propeller shaft
(see Figure 4 for detail of propeller shaft arrangement)

1.4.7 The main bilge pumping arrangement was a self-priming 230 volt pump, with suction lines to each pontoon. The pump was not automatically activated. The 230 volt power was produced by a shaft generator on the port engine, which had to be running for the bilge pump to operate.

1.4.8 A battery-operated bilge pump system had been installed. A pump was located in the engine section of each pontoon and was activated by a float switch. There was no indication on the control panel in the cockpit whether either pump was running. These pumps had a capacity of 2000 gallons per hour and were intended only to control minor water ingress. As a last resort there was also a hand-operated pump.

1.4.9 *Scat Cat* was a one-off design and had been built to the owners requirements that it was to be:

- of external dimensions that would enable it to pass through Ohau Channel
- of an operating draught of 2 feet 6 inches (0.76 m)
- highly manoeuvrable
- capable of carrying 50 passengers (equating to a full bus load of tourists)
- capable of 20 knots
- capable of maintaining a speed of two and a half knots for fishing charters.

1.4.10 *Scat Cat* was delivered to the owner in December 1991 but was not put into service until 10 July 1992. The delay was caused mainly by the inadequacy of the gearboxes that were fitted. The original gearboxes had a ratio of 1.09 : 1 which was incompatible with the engines and drive shafts fitted. After a lengthy dispute between the owner and the builder, new gearboxes were fitted by the owner.

1.4.11 *Scat Cat* was surveyed by Marine and Industrial Inspection Services (M&I), initially in Auckland during building and subsequently in Rotorua after delivery. Sea trials were conducted on Lake Rotorua and it was during those trials that the inadequacy of the original gearboxes came to light.

1.4.12 Statical stability calculations were made following an inclining experiment carried out at Rotorua. Because the vessel was approved to carry up to 50 passengers, damaged stability certification was not required. Damaged stability certification requires that the vessel remain stable with one of its compartments flooded, but was only required for vessels that carry "more than 50 passengers".

1.4.13 Once in service, the majority of the on-going maintenance was carried out by the owner. He used local contractors only for those tasks that he was not able to complete himself. In the main these included repairs to the aluminium hulls and manufacture of replacement propeller shafts and propellers.

1.4.14 When it was necessary to renew propeller shafts, the shafts were manufactured locally. The original steel used was of type AISI T316. Each new shaft was made from a certificated lot of steel. One of the tests to completed shafts was to turn them in a lathe at the full operating rotation speed to verify the balance. It was noted that the shafts made of the original specification steel suffered slight "whirling", a condition in which the straight shaft takes up a curved shape.

1.4.15 The type of steel used for propeller shafts was changed to ASTM A S316. Shafts were made to the same dimensions but when tested no whirling was noted with the new material.

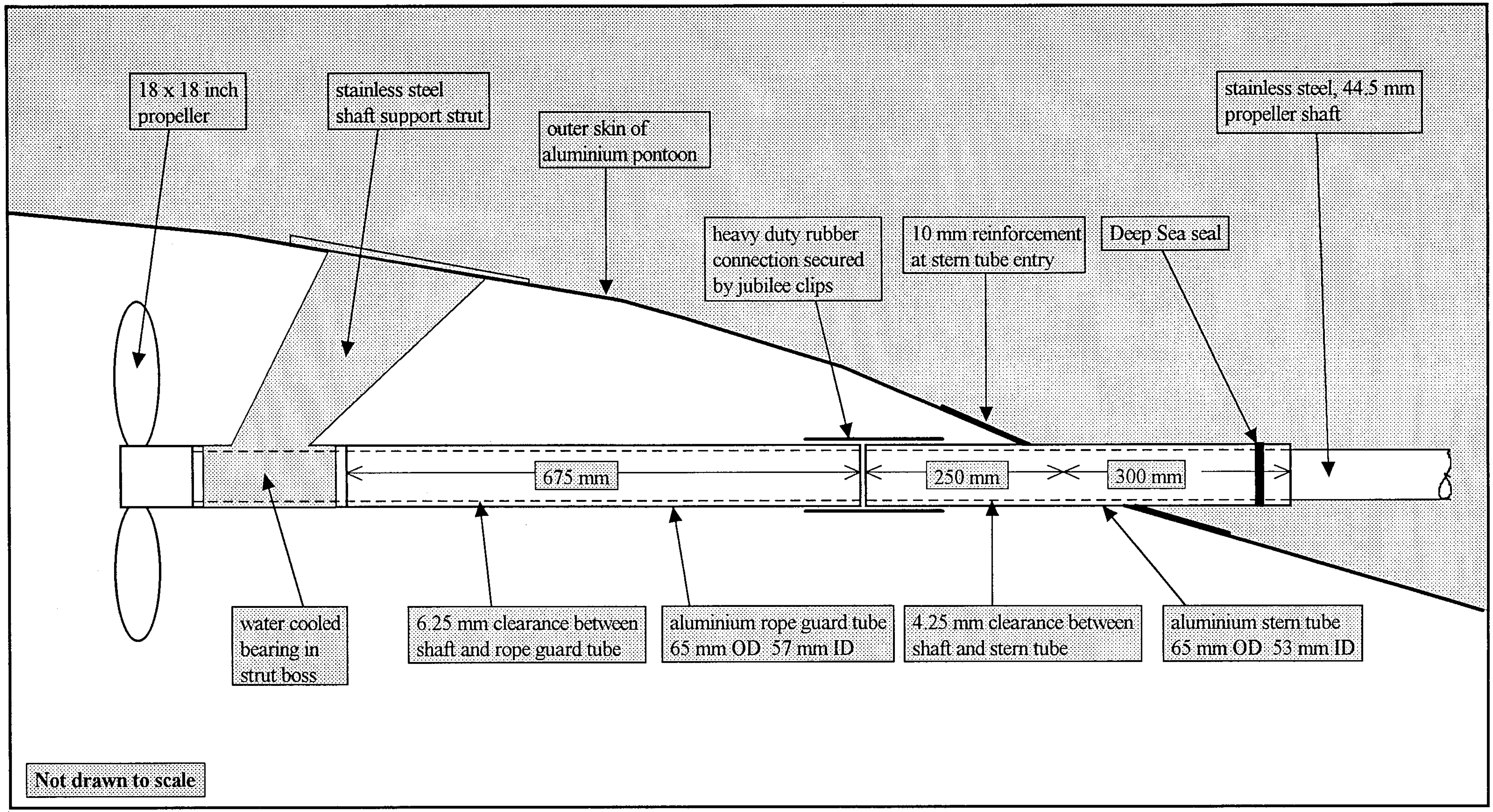


Figure 4
Line plan of *Scat Cat* showing detail of propeller shaft arrangement

1.4.16 Due to the shallow water conditions in which the vessel operated and the coarse sandy lake bed, the renewal and maintenance of the various components of the propulsion system was a frequent occurrence. Maintenance records kept by the owner since the vessel entered service and up to July 1998 indicated that:

- both propellers had been replaced 14 times
- both propeller shafts had been straightened twice and replaced once
- the port stern tube had been replaced three times and the starboard one replaced once
- the port shaft strut bearing had been replaced seven times and the starboard one six times.

1.4.17 The maintenance carried out by the owner was on an on-going basis and not necessarily subsequent to or in readiness for a survey or safe ship management audit inspection.

1.4.18 Life-saving flotation appliances consisted of:

- four Saltraft 573 buoyant apparatus, lifefloats capable of supporting 16 persons
- three lifebuoys of which one was fitted with a light and one with a line.

1.5 Damage information

1.5.1 At the repair facility both engines were removed so that they could be stripped down after being submerged in the lake, and to give access to the internal sections of the pontoons.

1.5.2 The aluminium rope guard on the port side of the vessel was missing. To the outboard side of the port propeller shaft there was a section of the hull that had been damaged, possibly where the rope guard had contacted when it was torn free. (See Figure 4).

1.5.3 The outboard section of the port stern tube had been partially torn from the pontoon hull creating a hole through the skin of the pontoon. The tube was worn from the inside to such an extent that the original wall thickness of 6 mm was reduced to zero on one edge of the section of tube remaining in place. (See Figures 3, 4, 6 and 8).

1.5.4 The inboard section of the port stern tube had worn from the inside of the tube to such an extent that it had worn a hole about 200 mm long and averaging about 15 mm wide on one side of the tube. No wear was apparent on the opposite side of the tube. (See Figures 5 and 8).

1.5.5 The starboard propeller shaft rope guard (see Figures 7 and 9) was removed and was found to be worn from the inside of the tube and on one side only. The original wall thickness of 4 mm was reduced to about 1 mm in the worn area . One side of the strut bearing, which was fitted into the rope guard tube, was completely worn away.

1.5.6 The starboard stern tube was worn on one side down to about 3 mm from the original thickness of 6 mm.

1.5.7 The deep sea seals fitted to the inboard ends of the stern tubes were intact.

1.5.8 The condition of the internal sections of the pontoons indicated that, in addition to the engine bay sections, the section containing the storage tanks and to a lesser extent the forward and aft void spaces had also flooded.

Hull penetration from the outboard side

Hull penetration from the inboard side

Figure 5
Views of damage to port stern tube entry

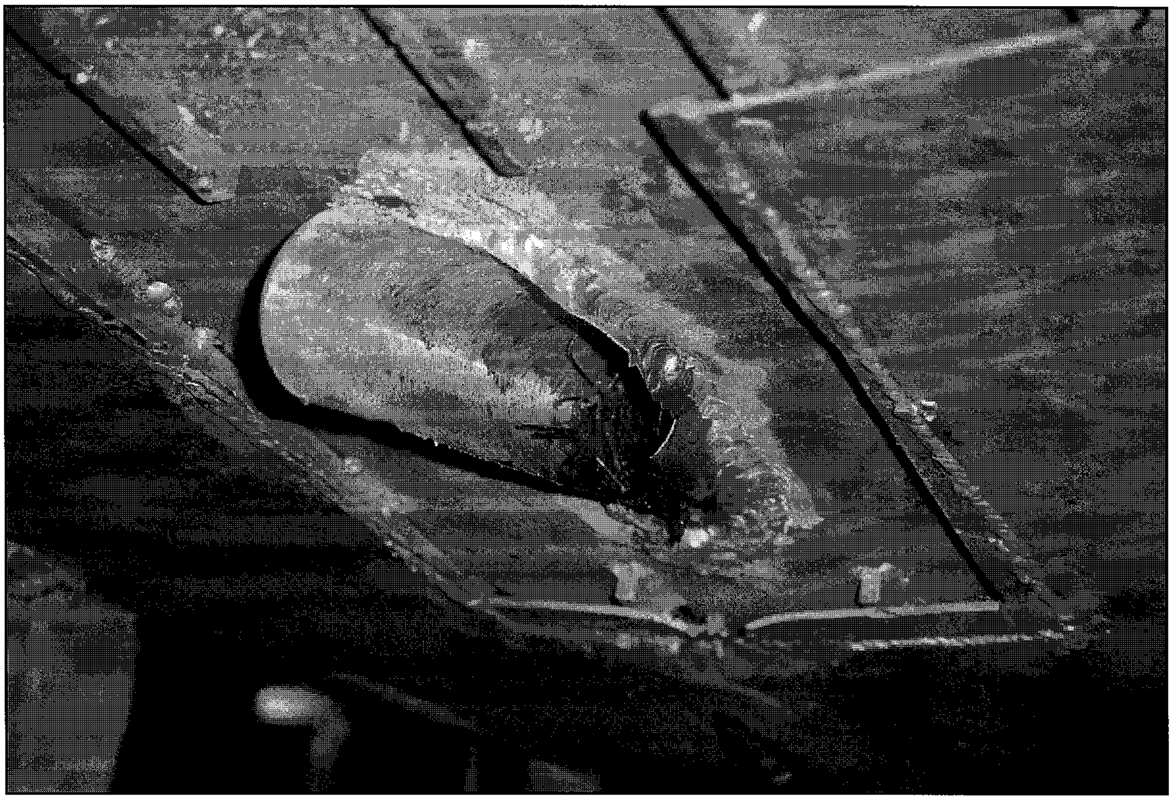
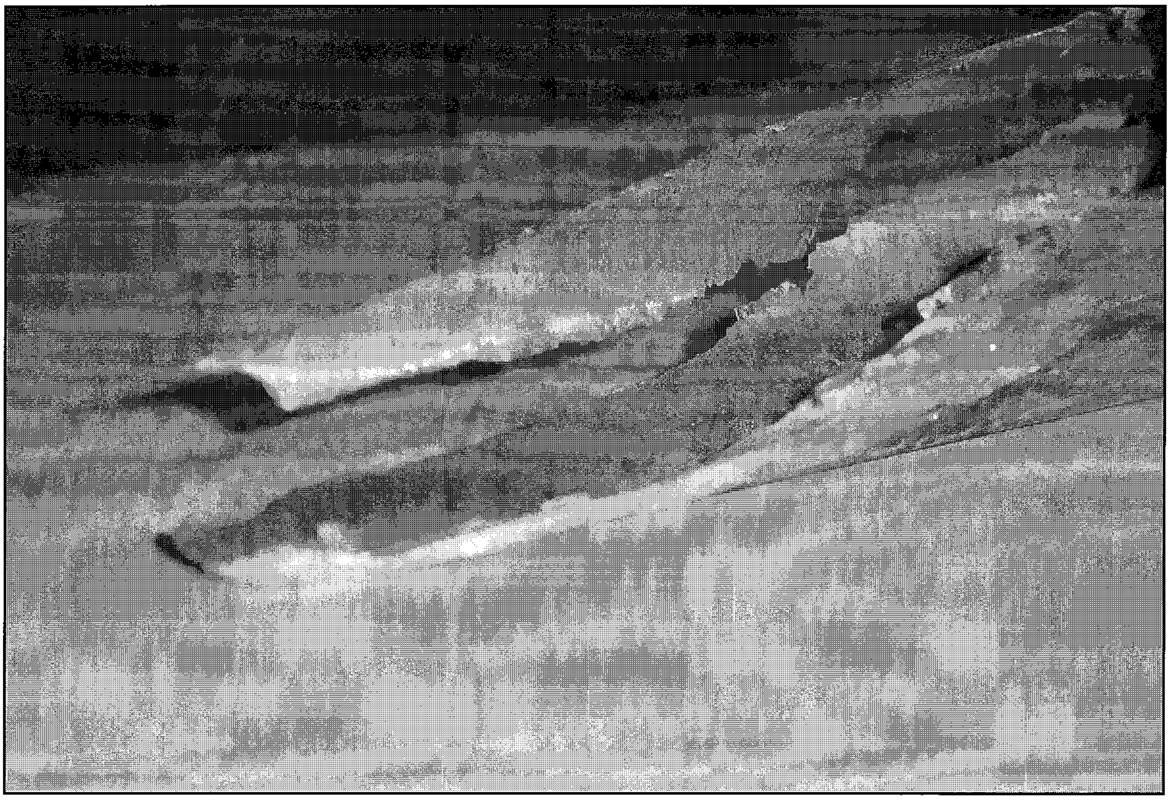
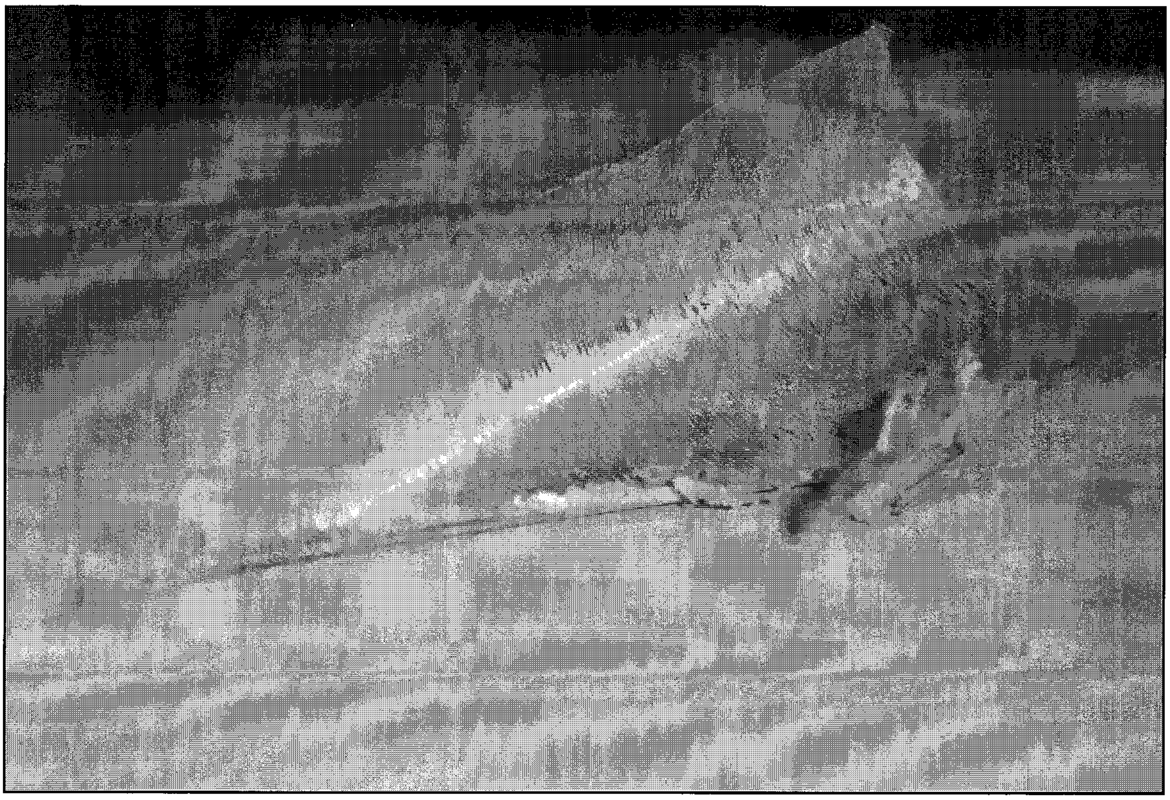


Figure 6
Damaged stern tube after removal of propeller shaft
Note exposed remains of old heat exchanger

Figure 7
View of intact starboard propeller shaft arrangement



Inboard section. Note hole worn right through tube



Outboard section. Note thinness of remaining aluminium

Figure 8
Port stern tube sections after removal showing wear to inside of tube

1.5.9 Both propeller shafts were worn beyond allowable tolerances but had also been bent during the salvage operation. Survey rules allowed for a minimum propeller shaft diameter of 42.58 mm for the propulsion system installed on *Scat Cat*.

1.6 Vessel inspection information

1.6.1 The access plates in the watertight bulkheads were held in place with set bolts and a seal provided by a silicon sealant compound. On the bulkheads between the engine and tank sections, about 50 percent of the set bolts were missing. On the bulkheads between the tank and the forward void space sections, about 20 percent were missing.

1.6.2 The side cover plates to the engine compartment were similarly held in place. The plate was slightly distorted and in places was not sealed against the hull.

1.6.3 Where the propeller shaft struts were bolted to the pontoon, the internal construction in the area had a longitudinal stiffener each side of the bolted plate to give added strength. In both hulls these stiffeners were distorted. Where the stiffeners met the frame aft of the bolted plate there were small cracks in the frame.

1.6.4 The bolts holding the port side propeller shaft bracket had been fitted over springs. This action had reportedly been taken to overcome the occasional loosening of the bolts on that side.

1.6.5 In September 1997, both propeller shaft struts had been strengthened by the addition of a brace connecting each side of the vertical member to the flat plate at the hull. On the starboard strut this had produced a noticeable distortion of the flat plate.

1.6.6 The original heat exchanger systems had run water through channels in a pontoon double skin in the aft section above the propeller shafts. The system had not functioned well and about two years prior to the accident, the owner had re-run the cooling through external pipes on the inner side of each pontoon.

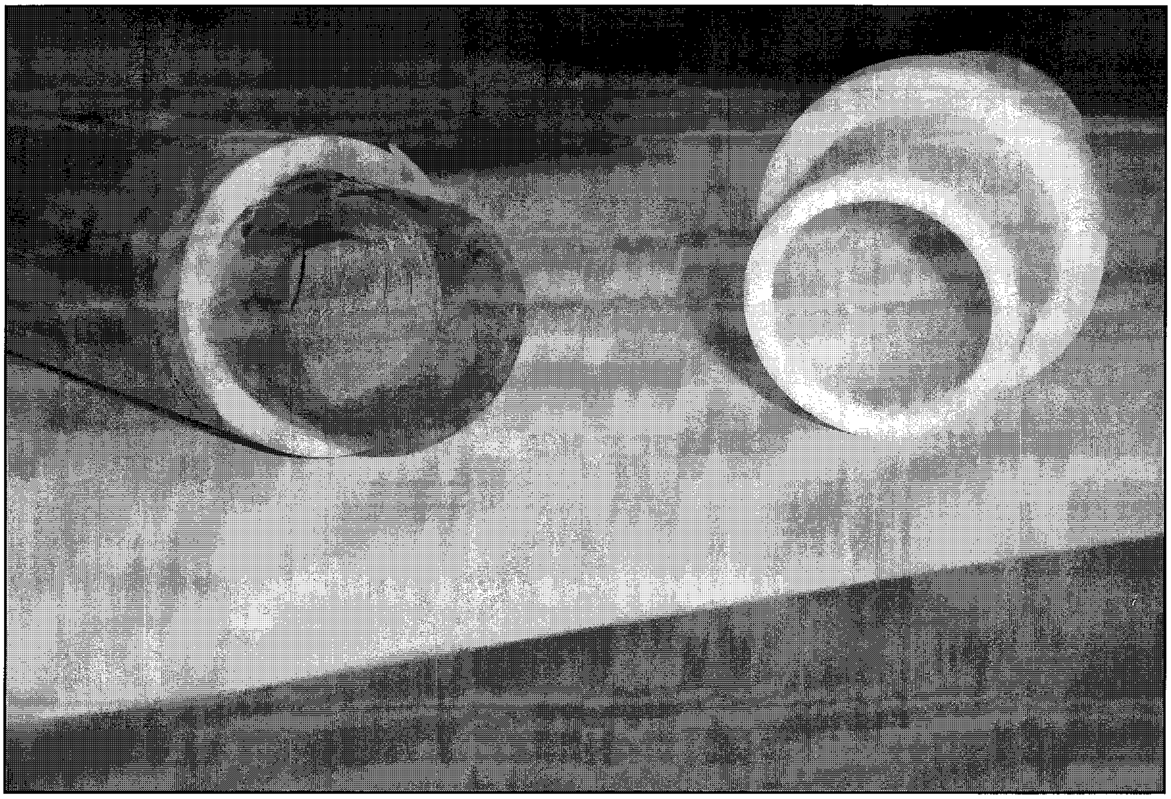
1.6.7 At the time of modifying the heat exchanger system it had been intended to remove the old system. The external cover of the double skin on the port pontoon had been removed. This work had been time consuming and costly and was abandoned as being unnecessary. The dividers that had been in the double skin to produce water channels remained in place. (See Figure 6).

1.7 Survey and Safe Ship Management information

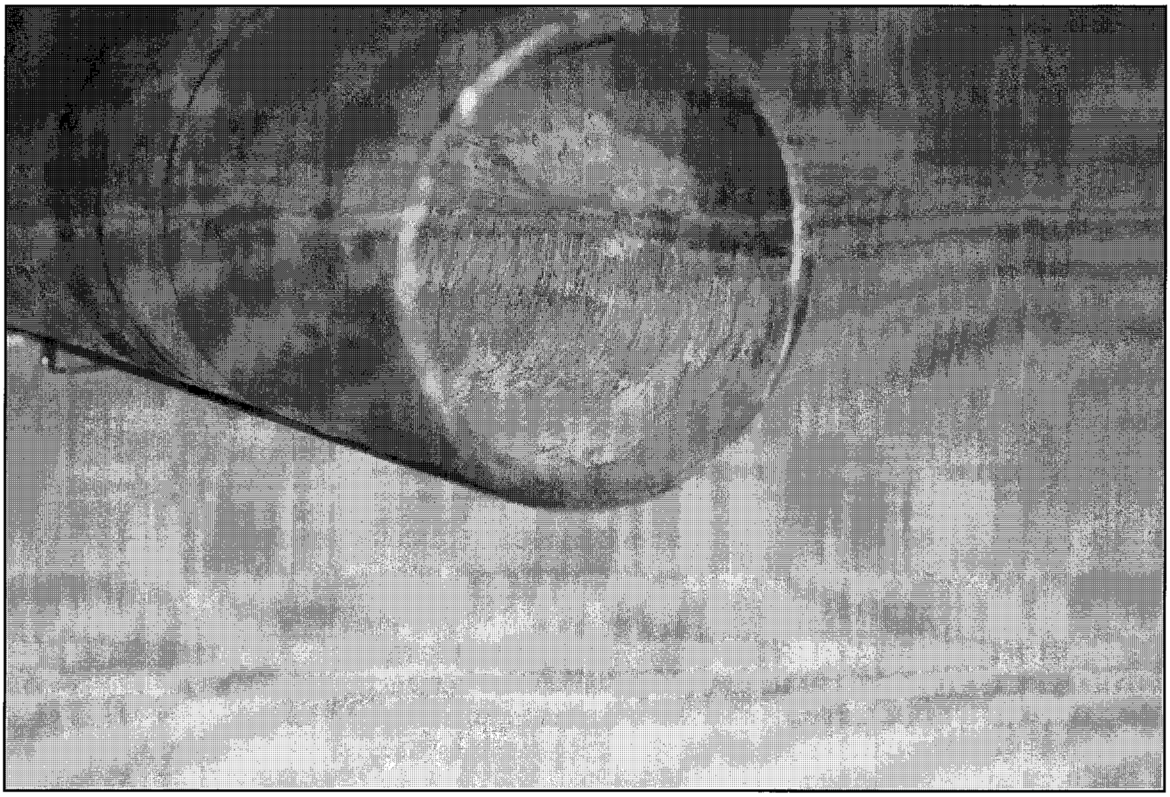
1.7.1 *Scat Cat* had been surveyed by M&I throughout its history, initially in Auckland during construction, and later in Rotorua during operation. Plan approval was carried out by M&I, which was then part of the Maritime Transport Division of the Ministry of Transport. On completion of building *Scat Cat* was delivered to Rotorua where sea trials and the final survey were carried out.

1.7.2 *Scat Cat* was delivered to the owner in Rotorua in December 1991. The first visit by the local M&I surveyor was recorded as being on 23 December that year. Because of various delays, the first Certificate of Survey was not issued until 10 July 1992, enabling the vessel to be put into service.

1.7.3 Under the old survey system, *Scat Cat* was surveyed annually until the certificate renewal date of 10 July 1996. The survey certificate was renewed in November 1996 but it was valid only until 31 January 1998, by which time *Scat Cat* had to be entered into a safe ship management system. *Scat Cat* underwent annual survey in November 1997.



Aft end. Note complete wearing of one side of bearing. New bearing shown.



Forward end. Note thinness of tube in way of wear.

Figure 9
Starboard rope guard showing one-sided wear to inside of tube.

1.7.4 The owner of *Scat Cat* decided that for the purposes of safe ship management he would continue to use M&I. There had been a long association between the owner and M&I with regards to the vessel, and both parties agreed that the transition from the survey system to safe ship management had been straightforward.

1.7.5 On 15 January 1998 an Exemption from Survey Certificate was issued by the Maritime Safety Authority. M&I approved the Ship Safety Manual on 21 January 1998. The vessel underwent initial audit on 23 February 1998. A Fit for Purpose Certificate was issued on that date and a Safe Ship Management Certificate issued on 25 February 1998.

1.7.6 *Scat Cat* underwent an audit inspection on the slip on 4 August 1998 and another while afloat on 25 August 1998, at which time an Interim Fit for Purpose Certificate was issued. The Safe Ship Management Certificate was re-issued on 2 September 1998.

1.7.7 Subsequent to the inspection on 4 August a Corrective Action Repair (CAR) Notice was issued to the owner. The following actions were required and subsequently completed:

- Port shaft renewed in 44.5 mm stainless steel.
- Starboard shaft skimmed to 42.0 mm and new high density bush fitted in strut.
- Both rudders and stocks renewed with high density plastic bushes fitted.
- Starboard hull exhaust flange and cracks in hull welded and stiffened.

1.7.8 The completion of these actions was the responsibility of the owner. Under the M&I safe ship management system, unless stipulated in the CAR, there was no requirement that the surveyor re-visit the vessel to inspect a completed repair regardless of its importance or complexity.

1.8 Site information

1.8.1 The wharf office and the berths for *Scat Cat* and the company's other vessel *Ngaroto* were situated at the main jetty on the lakefront at Rotorua. The *Ngaroto* moored at the jetty and the *Scat Cat* about 30 metres to the east, both using the jetty to embark and disembark passengers during the day.

1.8.2 The depth of water at the mooring and alongside the jetty was about 0.75 m. The bottom was coarse sand and a channel away from the jetty was maintained by the constant movement of the *Ngaroto* and *Scat Cat* into and out of their berths.

1.8.3 The draught of *Scat Cat* was about the same as the depth of water around the jetty area. When the *Scat Cat* was manoeuvring around the area, its propwash was continually scouring the sandy lake bottom.

1.8.4 The area around Hamurana where *Scat Cat* berthed while passengers made a bushwalk was also shallow with a coarse sandy bottom.

1.8.5 The depth of water to the south of Mokoia Island where the *Scat Cat* sank was about 11 m.

1.8.6 The area of Lakes Rotorua and Rotoiti in which the *Scat Cat* operated had weed growth throughout that was prolific in places.

1.9 Personnel information

1.9.1 The skipper had been at sea since 1960, sailing as Able-Bodied Seaman (AB) on British ships for ten years. In 1970 he emigrated to New Zealand and sailed as AB on coastal vessels. At the introduction of the Integrated Rating (IR) scheme in New Zealand, he attended the Australian Maritime College in Launceston in 1989 and gained his IR certificate. He also gained his Commercial Launchmaster Certificate (CLM) in 1989 but continued to sail as IR on coastal vessels until 1994, when he took early retirement. He commenced working with Scat Cat Cruises in 1995.

1.9.2 The skipper had been on sick leave from January 1998 and had returned to work on the day before the accident. On Wednesday, 23 September, his first day back at work, there had been no passengers and, therefore, no trips. He spent the day around the vessel and the office.

1.9.3 The duty roster dictated that the skipper worked from Wednesday to Sunday. The owner skippered the *Scat Cat* on Mondays and Tuesdays.

1.9.4 The crew member had been working for Scat Cat Cruises for about two years. She had no formal marine qualification. Her duties included assisting the skipper berthing and unberthing the vessel and being hostess to the passengers during the cruise.

1.9.5 The duty roster dictated that the crew member worked from Monday to Friday. Another crew member was rostered to work at weekends.

2. Analysis

2.1 The foundering

2.1.1 Analysis of the damaged components indicated that both propeller shafts had been contacting the inside of the stern tubes and rope guards, until the tubes on the port side failed and allowed the ingress of water into the port pontoon of *Scat Cat*.

2.1.2 At some time during the two trips on the day of the accident, the wear on the inside surface of the port rope guard progressed to the extent that a hole was formed. Once holed, the guard was no longer effective and would have allowed foreign material, probably weed and coarse sand, to enter the space between the guard and the propeller shaft.

2.1.3 Any foreign material entering the space would have been rotated with the shaft. As the material built up, the shaft would bind to the rope guard tube and attempt to rotate it. Because the rope guard tube was attached to the outer end of the stern tube by a heavy duty rubber clamp, it would attempt to rotate the stern tube also.

2.1.4 The stern tube was already weakened by the extensive wear to the inside of the tube caused by the propeller shaft, and the turning action would have wrenched a section of it free from the pontoon to be lost together with the rope guard tube.

2.1.5 The skipper had no problems with the engine on the first trip of the day nor on the outward leg and circuit of the island on the accident trip. The build-up of foreign material probably continued during this time until the shaft and tubing arrangement could tolerate no further strain. The application of full throttle for the return trip probably caused the final failure of the port rope guard and outboard section of the port stern tube. The additional load on the port engine by the binding of the shaft and the resulting damage was probably responsible for the reduced rpm available to the skipper.

2.1.6 Without the rope guard in place, and a section of the stern tube torn free, water was able to flow into the stern tube entry. Had there been no damage to the stern tube inside the pontoon, the water ingress would have been halted by the deep sea seal. The hole that had been worn through the stern tube inside the pontoon was between the hull and the seal. Thus there was nothing to stop the ingress of water and the port engine space began to flood.

2.1.7 The skipper neither heard nor felt the damage occur and at that early stage would have had no indication of the problem because of the normal attitude of the vessel. Having previously experienced engine power reduction caused by the slipping of throttle cables, he presumed that to be the cause of his current situation. He advised the wharf office staff and busied himself with correcting the conceived fault.

2.1.8 During his repair efforts the water entered the port pontoon at a high rate. The automatic bilge pump would have been activated by the float switches in the engine space but with no indication in the cockpit the skipper was not alerted to the actual problem. As water continued to enter the port pontoon *Scat Cat* took on an increasing port list and trim by the stern.

2.1.9 The skipper was engrossed in his repair attempts and, working in the confined space of the cockpit, did not notice the worsening attitude of *Scat Cat* until he went to investigate the engine end of the throttle cable. By this time the list and trim had become more severe and he radioed the wharf office and requested assistance.

2.1.10 The wharf office staff were able to assure the skipper that two boats were being dispatched. The skipper busied himself with attempts to identify the point of ingress and to stem the flow. In the knowledge that other boats were proceeding to his aid, the skipper made no further distress calls. It would have been appropriate for the Search and Rescue section of the Police and the local Coastguard to have been alerted and placed on stand-by either by a call direct from the skipper or through the wharf office.

2.1.11 The skipper attempted to start the main bilge pump but was unable to start the port engine to provide the power. At this stage the engine would have been immersed.

2.1.12 As the list and trim increased, the air intake to the port engine space would have become submerged, dramatically increasing the ingress of water. As a result *Scat Cat* settled quickly in the water and the air intake to the starboard engine became submerged allowing ingress of water to the starboard pontoon further increasing the rate at which *Scat Cat* settled in the water.

2.1.13 With both pontoons filling, the list reduced but the vessel settled rapidly by the stern. Had the water been confined to the two engine spaces *Scat Cat* would have had no power but would probably not have sunk.

2.1.14 The watertight integrity of the bulkheads between the engine spaces and the tank spaces was compromised by missing bolts and inadequate sealing. Water was able to pass from the engine spaces into the tank spaces and the vessel continued to settle by the stern and sank rapidly in about 11 m of water.

2.1.15 The timeframe from initial damage to final sinking would have been about 30 minutes with events accelerated in the later stages. Once the skipper realised that there was more than an engine control problem, his preparation of lifesaving appliances, mustering of passengers, and then his decision to abandon ship were all appropriate and effected in good time.

2.1.16 The transfer of passengers and crew from *Scat Cat* to lifefloats was carried out in a timely and orderly fashion. The use of lifesaving equipment was appropriate and the equipment used proved to be adequate for the numbers involved.

2.1.17 The response of the two rescue craft was swift and effective, arriving at the scene about 10 minutes after *Scat Cat* had been abandoned. It was appropriate that an ambulance was summoned to check the passengers and crew.

2.2 The vessel

2.2.1 The *Scat Cat* operated in depths of water the same as or close to its own draught. The areas in which it operated had a coarse sandy bottom. As such, the area of operation would be considered as hostile with the potential for vessel damage to be high.

2.2.2 The high incidence of repair and renewal of propellers, shafts, rope guards and stern tubes was evidence of the risk to vital propulsion equipment and the safety of the vessel, while operating in what could be considered as a hostile environment for *Scat Cat.*

2.2.3 The clearances around the propeller shafts of 4.25 mm in the stern tube and 6.25 mm in the rope guard might have been adequate for a vessel operating in less hostile conditions. The slightest misalignment of the propeller shaft would, however, bring the shaft into contact with the inside surface of the tubes.

2.2.4 The area of the port pontoon where the original heat exchanger had been partially removed was above the propeller shaft. The parts of the heat exchanger system that remained in place affected the flow of water past the area and would have created turbulence and possibly cavitation around the propeller shaft arrangement.

2.2.5 The surface contact between the shafts and tubes on *Scat Cat* was such that the port side tube wore right through and the starboard side tubing had a high percentage wear. The wear would indicate that there had been misalignment between the propeller shafts and the tubes.

2.2.6 The misalignment probably resulted from various facets of the vessels operation:

- continual operation at a draught the same or close to the depth of water
- the necessity to continually scour the channel at the main jetty
- the probable frequent light groundings in the shallowest areas of operation
- the probable light groundings while at its moorings, caused by the movement of the vessel when it was buffeted by wind and waves in poor weather.

2.2.7 Although no whirling of the propeller shafts in use was noted during testing, it was possible that under operational conditions at various rotational speeds some whirling of the shafts might have occurred and produced further contact between the shafts and the tubing. However, the wear to the insides of the tubes was on one side only rather than all round, indicating that contact with the shafts was caused by misalignment.

2.2.8 The reduction of the watertight integrity of the watertight bulkheads contributed to the sinking of the vessel but their position within the vessel was such that in normal operation they could not be seen. In order to inspect the bulkhead between the engine space and the tank spaces it would have been necessary to have removed the engines, an unreasonable expectation for either the owner or any inspecting surveyor.

2.3 Maintenance and survey

2.3.1 The on-going maintenance and repairs to *Scat Cat* were carried out by the owner wherever possible and over the life of the vessel, he had gained experience in most of the work required. The frequency of repair and renewal of items of propulsion equipment would have made him conversant with the fitting requirements and methodology.

2.3.2 The owner had fitted new propeller shafts on many previous occasions and there was no evidence to suggest that there had been anything amiss with the replacement that he made to the port side on 4 August 1998, which was the last replacement prior to the accident.

2.3.3 The replacement of the port propeller shaft had been required by the M&I surveyor because of wear beyond allowable tolerances.

2.3.4 The owner of *Scat Cat* was experienced at changing propeller shafts but, in common with many owner/operators, he was not a qualified marine engineer.

2.3.5 The responsibility to complete required corrective repairs lay with the owner/operator. The M&I safe ship management system did not require their surveyors to return and inspect any completed corrective actions. When a corrective action repair is of a significant nature, rather than leave it solely to the owner/operator, it would be prudent to insist on an inspection of the completed repair by a surveyor.

3. Findings

The findings and safety recommendations are listed in order of development and not in order of priority.

3.1 The *Scat Cat* was manned with the appropriate number of crew.

3.2 The skipper of *Scat Cat* held the required qualification to command the *Scat Cat*.

3.3 The Safe Ship Management Certificate for *Scat Cat* was valid.

3.4 Misalignment between the propeller shafts, stern tubes and rope guard tubes occurred at some time prior to the accident. No cause of the misalignment was identified.

3.5 The misalignment caused the stainless steel propeller shafts to come into contact with the inside surfaces of the aluminium stern tubes and propeller shaft rope guard tubes.

3.6 The contact between the port propeller shaft and the tubes caused wearing on one side of the tubes to an extent that holes were worn in the inboard and outboard sections of the stern tube and in the rope guard.

3.7 Once the tubes were holed, foreign material entered the tubes and was caught by the rotating shaft.

3.8 The foreign material built up until the shaft bound to the tubes, wrenching the rope guard off and the outboard section of the stern tube partially free of the hull.

3.9 With the outboard section of the stern tube open to the sea, water was free to enter the hull through the hole that had been worn in the inboard section of the stern tube.

3.10 The deep sea seal on the port stern tube was intact but rendered ineffective by the damage that had occurred on the aft side of it.

3.11 The ingress of water to the port hull created a port list and stern trim which increased to an extent that allowed water to flow into the port engine air intake, further increasing the list and trim.

3.12 The port list and stern trim increased to an extent that allowed water to flow into the starboard engine air intake. The ingress of water to the starboard side corrected the list but increased the stern trim.

3.13 The ingress of water was not contained in the two engine sections of the pontoons because the watertight integrity of the pontoon watertight bulkheads was not intact.

3.14 Progressive flooding continued until the vessel sank stern first.

3.15 The actions taken by the skipper for the safety of his passengers and crew were appropriate.

3.16 In addition to alerting the company, it would have been prudent for the skipper to have alerted the emergency services to his distress, even though assistance had been dispatched.

4. Safety Actions

4.1 After the accident the following repairs and modifications were carried out:

- both propeller shafts were renewed in the same material
- both stern tube entries were renewed. The new tubes were stainless steel of 63.5 mm internal diameter, increasing the clearance with the propeller shafts to 9.525 mm, and fitted on stainless steel plates which were bolted through the hull
- both rope guards were renewed in wire-reinforced rubber and of 63.5 mm internal diameter increasing the clearance with the propeller shafts to 9.525 mm
- where the outboard ends of the stern tubes met the rope guard tubes, bushes were fitted to give additional support to the propeller shafts and to reduce the possibility of movement between the two tubes
- the original engine air intakes were welded shut and new air intakes fitted, extending from the engine trunking to the cabin top
- the cover plate that had been removed from the old heat exchanger on the port pontoon was replaced to give a smooth surface
- the starboard propeller shaft bracket was straightened where bracing had distorted it
- the springs fitted to the port propeller shaft bracket were removed
- all access doors in the pontoon watertight bulkheads were fitted with 3 mm neoprene gaskets and their bolting arrangements strengthened
- engine space side access doors were fitted with 3 mm neoprene gaskets and the bolting arrangement was strengthened
- hatches to the forward void spaces were fitted with rubber gaskets
- alarms were fitted in the cockpit to indicate activation of the battery-operated bilge pumps.
- an electronic system for the operation of gear shift and throttle to both engines was installed, eliminating the original cable arrangement which had a tendency to slip.

4.2 After the accident the following revisions were made to the safety manual:

- bilge alarm tests to be carried out under the daily/voyage checklist
- stern tube inspection to be carried out under the monthly maintenance checklist
- the frequency of slipping requirement was increased from two years to one year

4.3 In view of the above safety actions, no recommendations were made to the owner of *Scat Cat*.

5. Safety Recommendations

5.1 On 22 March 1999 it was recommended to the Manager of Marine and Industrial Safe Ship Management Services that he:

5.1.1 Introduce a policy that when Corrective Action Repair Notices are issued with regard to items that compromise a vessels fitness for purpose, a surveyor must personally inspect the completed repairs before approving the corrective action and issuing a new Fitness for Purpose Certificate. (005/99)

5.2 On 24 March 1999 the Manager of Marine and Industrial Safe Ship Management Services responded as follows:

5.2.1 Marine and Industrial already has a policy in place which requires the re-issue of a Fit For Purpose Certificate where a major Corrective Action has been issued or where a vessel has been involved in an accident.

In the case of Scat Cat and type of incident involved there is no requirement under Rule 21 for the vessel to be re-inspected after the incident. (Maritime Rule 21.13.19 and Rule 21.11 "Major Alterations (a) and (b)" - page 13.)

However the local Marine and Industrial surveyor in Rotorua and our Senior Naval Architect both visited the vessel during repairs to ensure a satisfactory standard of workmanship.

5.3 On 22 March 1999 it was recommended to the Director of Maritime Safety that he:

5.3.1 Instruct safe ship management companies that when Corrective Action Repair Notices are issued with regard to items that compromise a vessels fitness for purpose, a surveyor must personally inspect the completed repairs before approving the corrective action and issuing a new Fitness for Purpose Certificate. (006/99)

5.4 On 31 March 1999 the Director of Maritime Safety responded as follows:

5.4.1 We can advise that we can accept this recommendation.

For your information, it is presently a requirement of Maritime Rule Part 21.13(19)(a) that a new certificate be issued by a surveyor if a ship undergoes major modification or major repair.

The Maritime Rule Part 40 series, which deal with Design, Construction and Equipment of various classes of vessel make it clear that, for the purpose of compliance with Rule 21.13(19)(a) any ship to which this Part applies must undergo a survey by a surveyor recognised by the Director under Rule 46.29 for that purpose. The extent of the survey must be such that the surveyor is satisfied that the ship "is fit for its intended service and intended operating limits".

It is anticipated that Rule 40D, Fishing ships, will come into effect shortly and Rule 40A, restricted Passenger ships, later this year.

6. Applicable Maritime Rules

6.1 Part 21.13.19 states:

The owner of a ship to which this section applies must ensure that if the ship undergoes major modification, major repair, changes its operating limits temporarily or permanently, or increases its passenger carrying capacity the ship is not operated until the owner has obtained -

(a) a new certificate issued by a surveyor stating the particulars referred to in rule 21.13(2)(a) (i) to (vii) inclusive; and

(b) a new New Zealand Safe Ship Management Certificate issued under rule 21.13(11) stating that the safety management of that ship complies with the requirements of the *New Zealand Safe Ship Management Code*.

6.2 Part 21.11 Definitions states:

"Major alteration" and **"major repair"** mean the repair or alteration of a ship, or the replacement or removal or addition of any part of a ship, that is likely -

(a) to significantly affect the structural integrity, tonnage, freeboard, cargo or passenger capacity, crew or passenger accommodation, conditions of assignment of load line, watertight subdivision, stability, structural fire protection, or safety equipment of the ship; or

(b) to result in significant changes to the propulsion machinery, auxiliary machinery, or method of propulsion of the ship.

6.3 Part 21.13(2)(a) states:

No ship to which this section applies may enter or remain in an organisation's approved safe ship management system unless -

the owner is in possession of a certificate issued by a surveyor dated not more than 12 months prior to the date the ship entered the approved safe ship management system, which states:

(i) the particulars of the ship; and

(ii) the permitted operating limits assigned to that ship under rule 20.5(1); and

(iii) the maximum number of passengers that may be carried; and

(iv) that the ship is fit for its intended service and intended operating limits; and

(v) any minimum freeboards assigned under Part 47; and

(vi) any limitations on the use of the ship, including any restrictions on the carriage of cargo; and

(vii) that the ship complies with the applicable maritime rules and marine protection rules.

Approved for publication, 31 March 1999

Hon. W P Jeffries
Chief Commissioner