Report 06-204, fishing vessel, *Kotuku,* capsize and sinking, Foveaux Strait, 13 May 2006

Report 06-204

fishing vessel
Kotuku

capsize and sinking

Foveaux Strait

13 May 2006

Abstract

Shortly after 1415 on Saturday 13 May 2006, while travelling from Kaihuka, in the Breaksea Islands Group to Bluff, the fishing vessel *Kotuku* capsized and later sank. Six of the 9 persons on board perished.

The vessel was recovered for investigative purposes but was declared a constructive total loss by the insurance company.

Safety issues identified were:

- the effectiveness of the safe ship management system to maintain vessel compliance
- the operation of a commercial fishing vessel to transport passengers
- the general condition and fitness for purpose of the *Kotuku*
- the risk to maritime operations posed by performance impairing substances such as alcohol and drugs

Safety recommendations were made to the Director of Maritime New Zealand to address these issues.

The *Kotuku*

Contents

Figures

Abbreviations

EPIRB	emergency position indicating radio beacon
GM	metacentric height, a measure of stability of a vessel
GPS	global positioning system
GZ	righting lever
hp	horsepower, imperial measurement of power, equivalent to 0.746 kW
HRU	hydrostatic release unit
kg	kilogram(s)
kgf	kilogram force
kW	kilowatt, the SI measurement of power, equivalent to 1.341 hp
m	metre(s)
Maritime NZ	Maritime New Zealand (formerly Maritime Safety Authority)
mm	millimetre(s)
MSI(s)	Maritime Safety Inspector(s)
NIWA	National Institute of Water and Atmospheric Research
Part 21	Maritime Rules Part 21 (Safe Ship Management Systems)
Part 40D	Maritime Rules Part 40D (Design, Construction and Equipment – Fishing Ships)
Part 91	Maritime Rules Part 91 (Navigation Safety Rules)
SOLAS	International Convention for the Safety of Life at Sea 1974
SPAN	Safety Profile Assessment Number
SSM	safe ship management
SWAN	simulating waves nearshore
T (°T)	true (or degrees true)
THC	TetraHydroCannabinol, the active ingredient in cannabis resin

Glossary

"A" frame	a metal framework mounted on a gantry, used to lift or tip trawl nets
athwartship	at right angles to the fore-and-aft line of the vessel
bar	SI unit of pressure, equal to about 14.5 pounds per square inch
bulwark	a solid barrier along the side of a vessel above the height of the deck. It helps to stop people and gear falling over the side and to prevent water coming on board
butt block	a sturdy piece of wood secured inboard behind a butt joint in 2 hull planks to provide additional strength
carvel	a method of constructing wooden vessels by fixing planks to a frame so that the planks butt up against each other and form a smooth hull
caulking	a material that is driven into the seams between planks to stop leaks. Traditional caulking is loose cotton fibres which are hammered into the seam and payed with paint, after which the seam is faired with putty
dumb drift	a bronze pin with serrations that is used to fasten large wooden assemblies in boats, such as the stem or keel
fadge	a canvas sack of about a cubic metre in size that has 4 handles that enable it to be lifted
freeboard	the distance between the surface of the water and the main deck
freeing port	a hole in the bulwark, designed to allow water to drain off the main deck
free surface effect	adverse effect created by liquid shifting in a partially filled space; when the liquid moves as the ship rolls and pitches, its centre of gravity changes and this affects the centre of gravity of the entire ship; a virtual reduction of the metacentric height follows which reduces the ship's stability
gantry or gallows	a fixed metal structure near the stern of a vessel for supporting blocks and other fishing equipment
heart timber	the central woody core of a tree
hydrostatic data	the geometrical properties of the underwater form of the hull of a vessel
load cell	a transducer which converts force into a measurable electrical output – an electronic scale
Maritime NZ	the prevailing maritime regulator at the time of the occurrence. Unless specifically stated, Maritime NZ has been used to represent the maritime authority of the day
metacentre	the point of intersection between two vertical lines, one line through the centre of buoyancy of the hull of a ship in equilibrium and the other line through the centre of buoyancy of the hull when the ship is inclined to one side; the distance of this intersection above the centre of gravity is an indication of the stability of the ship
metacentric height (GM)	is the distance between the centre of gravity of a ship and its metacentre. The GM is used to calculate the stability of a ship
muttonbird	a seabird, also known as the sooty shearwater. These native seabirds are known as titi in Maori and are traditionally gathered, before they fledge, by members of Stewart Island iwi
near-drowning experience	survival after suffocation caused by submersion in water
net roller	a large winch drum that allows an entire fishing net to be wound onto it for easy retrieval and stowage

pound or pond	enclosed area where fish are landed or stowed. Divided into separate areas by wooden pond boards
pulmonary congestion	excessive accumulation of blood or other fluid in the lungs
pulmonary oedema	swelling and fluid accumulation in the lungs
sheathing	sacrificial timber attached to the hull of a vessel to prevent physical damage to the hull, particularly in the area where the trawl doors could hit while being hauled
significant wave height	the average of the biggest third of all the waves measured
stability	the ability of a vessel to return to the upright when heeled
stem	vertical member rising up from the keel at the front of the boat
TetraHydroCannabinol	the active chemical in cannabis
transom	the athwartship portion of the hull at the stern

Data Summary

Vessel Particulars:

Name:	*Kotuku*
Type:	fishing
Limits:	coastal limits of New Zealand trawling only within 12 miles of the coast of New Zealand
Safe ship management company:	SGS M&I
Length:	14.2 metres (m)
Breadth:	3.96 m
Gross tonnage:	25.64
Built:	1963 by Curnow and Wilton, Nelson
Construction:	carvel built of white pine planks over rimu beams
Propulsion:	Caterpillar D333 134 kilowatts (kW) (180 horsepower (hp)) 6-cylinder in-line diesel engine driving through a MG 512 Twin Disc 4.4:1 ratio gearbox a fixed-pitch 4-bladed propeller
Service speed:	8 knots
Owner/operator:	J Edminstin
Port of registry:	Bluff
Crew:	3
Date and time:	about 1415 on Saturday 13 May 2006
Location:	Foveaux Strait
Persons on board:	9
Injuries:	6 fatal 3 minor
Damage:	vessel sunk. Wreck recovered but deemed a constructive total loss
Investigator-in-charge:	Captain Doug Monks

Investigation methodology

The Rescue Coordination Centre of New Zealand notified the Commission at about 2000 on Saturday 13 May 2006, that there had been an accident involving the fishing vessel *Kotuku* near Womens Island in Foveaux Strait.

The Commission immediately launched an investigation. An investigator travelled to the area the following morning. The initial investigation involved liaising with the police and maritime regulator, taking statements from survivors and witnesses, and gathering general information on the area and the vessel.

The Commission in conjunction with Maritime New Zealand (which had launched its own investigation) saw the recovery of the wreck as an important component of the investigation. The Commission engaged a professional dive and salvage team, and using a window of favourable weather the team raised the vessel within 2 weeks of the accident.

The investigation was wide-ranging, with special attention paid to the hull integrity, vessel stability, survey history, machinery, effectiveness of the lifesaving appliances, and the regulatory system surrounding the operation and certification of the vessel.

The Commission adopted a preliminary report on 10 September 2007, which was distributed to interested parties. On 11 October 2007, in Invercargill, the Commission held a closed hearing of interested parties to receive verbal and written submissions on the preliminary report. After initial consideration of all submissions received, the Commission ordered further investigations into the post-accident stability testing and the condition of the hull and its fastenings.

The results of the follow-up investigations and changes arising from full consideration of the interested parties' submissions were incorporated into the final report, which the Commission approved at its meeting on 20 March 2008.

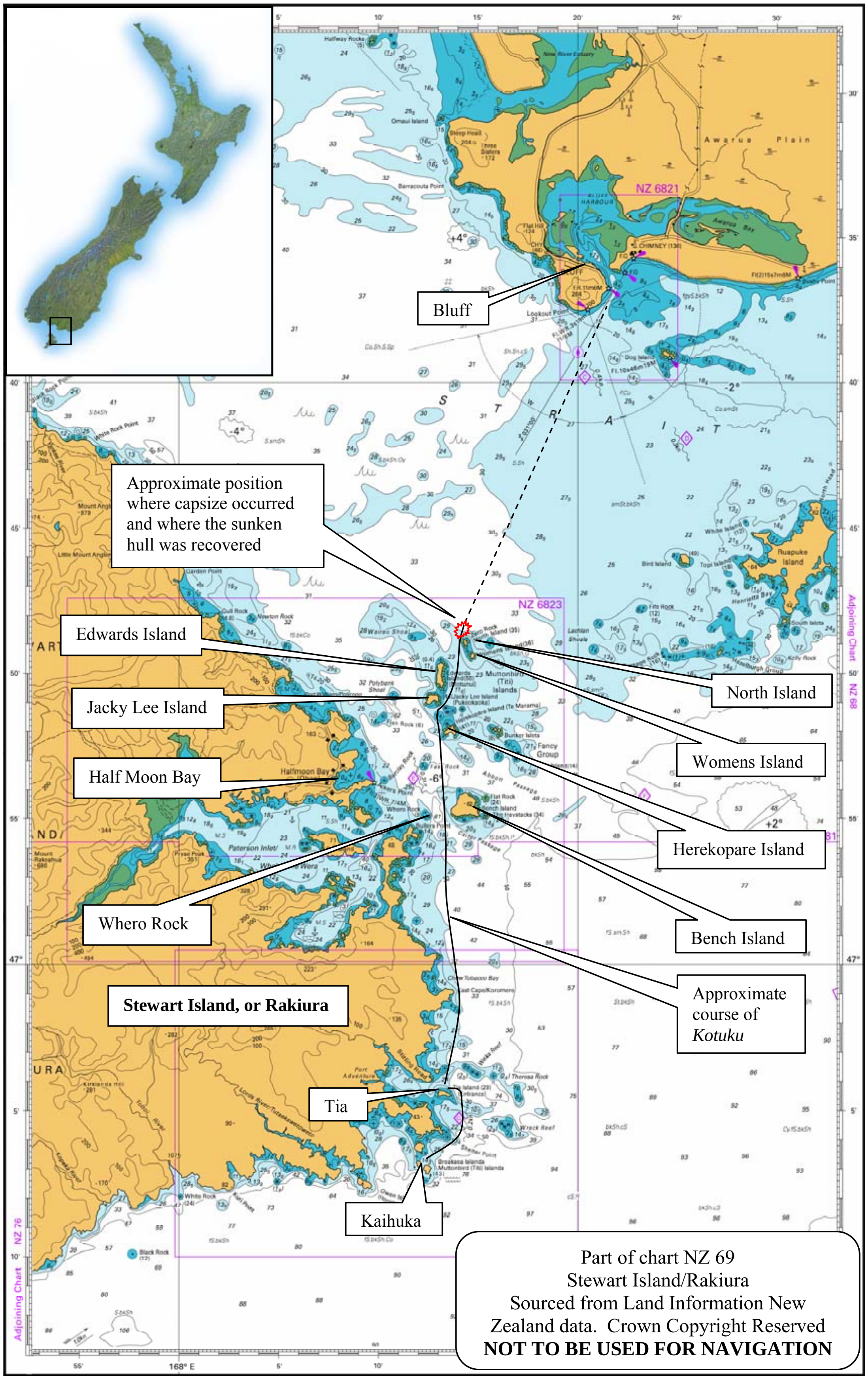


Figure 1
Chart of Foveaux Strait

1 Factual Information

1.1 Narrative

Note: The majority of time and positional information used in this report is based on the recollections of the survivors, who were not actively engaged in the navigation of the vessel, and so are approximate, particularly those after the vessel capsized.

1.1.1 At about 1200 on Friday 12 May 2006, the fishing vessel *Kotuku* departed Bluff and headed for Half Moon Bay, Stewart Island. On board were the owner, a deckhand and a friend of the owner. The trip was uneventful except for a problem with the throttle control for the engine, which required the throttle control lever to be wedged for it to remain in the required position. The vessel arrived at Half Moon Bay at around 1600, and once the engine was stopped the owner said that he repaired and adjusted the throttle control.

1.1.2 The following morning, Saturday 13 May, the *Kotuku* departed Half Moon Bay at about 0800 and headed for the island of Kaihuka in the Breaksea Islands Group, where the owner had agreed to pick up the former skipper of the *Kotuku* and his extended family who had been harvesting muttonbirds (see Appendix 3), and their cargo.

1.1.3 The *Kotuku* arrived at Kaihuka (see Figure 1) at around 1000 and waited with another vessel, the *Reliance*, which another muttonbirding family on the island were using to transport them and their cargo to Bluff. A helicopter arrived at about 1030 and started transferring cargo, first to the *Kotuku* and then to the *Reliance*.

1.1.4 Cargo, consisting of 4 fadges and a large gas bottle, was loaded onto the *Kotuku* in 3 lifts. The first fadge, containing buckets of muttonbirds, was landed in the afterdeck pond and some of the buckets were removed from the fadge and stowed into the next forward pond (see Figure 2). The second fadge, containing more muttonbirds, was landed behind the remnants of the first fadge in the after pond. The remaining 2 fadges, containing personal effects, a generator, spare fuel and muttonbirding equipment, and the gas bottle, were transferred in one lift. The fadge containing the generator and fuel was landed on the fish hold hatch and the other on the port side deck between the fish hold hatch and the wheelhouse. The gas bottle was laid in the pond, immediately aft of the fish hold hatch. It is unclear whether the cargo was lashed in place, although a rope was said to have been fastened across the fadge on the hatch. The total weight of the cargo was later estimated to be about 1000 kilograms (kg), comprising:

67 buckets of muttonbirds of about 11 kg each	737 kg
generator	50 kg
spare fuel, about 120 litres	120 kg
gas bottle (part full)	50 kg
general equipment, including clothes and bedding, tools, spare muttonbird buckets and provisions	50 kg

1.1.5 Once the helicopter had finished loading the 2 vessels, it flew the 6 family members (the previous skipper, his father, his sister and her 2 sons aged 16 and 9, and his own son aged 9 years) to Tia Island, about 3 miles to the north, where the vessel landing area was more sheltered than at Kaihuka. The other muttonbird family comprising 2 adults were able to transfer from the beach at Kaihuka to the *Reliance* by dinghy. The *Reliance* steamed directly to Bluff, going outside the Muttonbird Islands. The *Kotuku* steamed to Tia, arriving there at about 1115, whereupon the family members embarked by dinghy. Once on board, the father took the helm and steered them towards Bluff. The other people were variously engaged in checking the stowage of the cargo, eating, drinking and talking. The 3 younger people were resting or sleeping in the forward cabin.

1.1.6 The family had considered that, if the weather was bad and the trip was expected to be uncomfortable, they would divert to Half Moon Bay for the sister and children to catch a commercial ferry to Bluff. However, with the wind from the northwest at between 15 and 20 knots and a slight to moderate sea (see Appendix 1) the family determined that the conditions were satisfactory for the whole group to continue to Bluff on board the *Kotuku*.

1.1.7 The father, who had many years' experience of the waters around Stewart Island, steered the vessel up the eastern coast of Stewart Island before going between Bench Island and Whero Rock (see Figure 1). From there he passed to the west of Herekopare Island, between Jacky Lee Island and the reef lying to the southeast of it, and then between Edwards Island and the North Isles. The owner was not taking an active part in the navigation of the vessel, but did notice from the global positioning system (GPS) that they were making about 6 knots. One of the crew members said that the throttle lever mechanism would not remain at the set ahead position and that a knife was used to wedge the lever in the required position. However, even with the knife, the combination of tension on the throttle cable and vibration caused the lever to return and stay at about the half ahead position; the crew left it in that position.

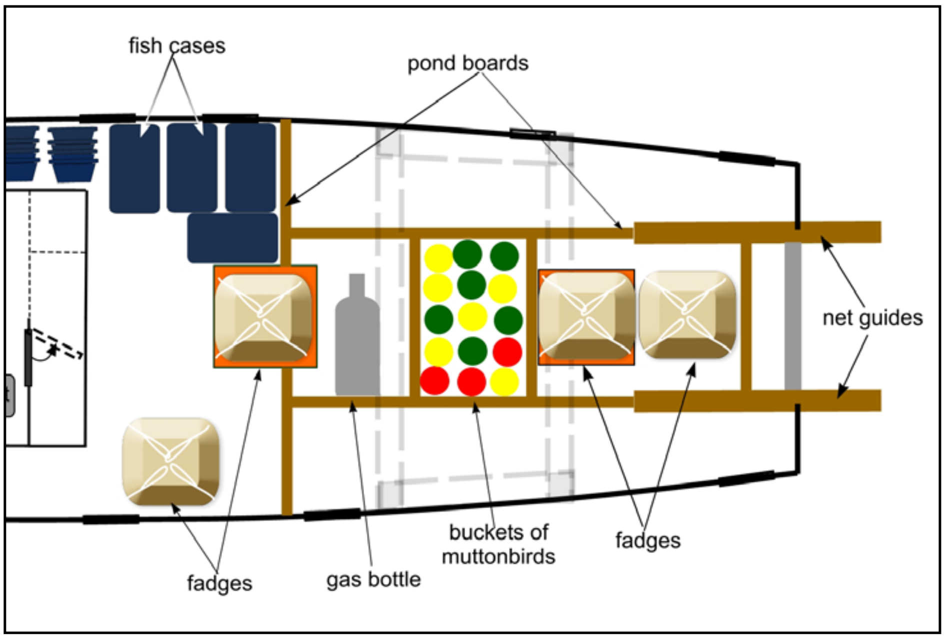


Figure 2
Approximate stowage position of cargo

1.1.8 Between 1415 and 1430, when they were off the northwest corner of North Island, 2 larger than average waves were reported to have struck the port side of the vessel. The first wave caused the vessel to roll heavily to starboard, sufficient to cause unsecured items in the wheelhouse to shift. The vessel recovered from this roll, righted itself and rolled heavily to port. The second wave caused the *Kotuku* to again roll to starboard, but this time it rolled smoothly and continuously until it capsized, coming to rest fully inverted. As the first of the larger waves hit the *Kotuku*, it was suggested that the father had either altered course to starboard to put the stern of the vessel to the sea or that the bow had been turned to starboard by the effect of the wave. The next helm control was reported to have been hard to port. This was reported to be the position of the helm when the vessel capsized. During the last roll to starboard, the deckhand, who was on deck near the doorway at the back of the wheelhouse, was heard to say that something was wrong and that fish cases were floating off the deck.

1.1.9 As the vessel took the last roll to starboard, the father was seen to fall or be thrown from the helmsman's position across the wheelhouse. The other people were able to maintain their position until the vessel capsized and water flooded the now inverted wheelhouse. After the capsize, 5 of the occupants were able to escape from the wheelhouse and get to the surface; however, the father, the sister and the 2 younger boys remained trapped. They perished in the upturned hull.

1.1.10 The owner and his friend used a cargo fadge that had floated to the surface to support them. The other 3 survivors (the former skipper, his 16-year-old nephew and the deckhand) climbed onto the upturned hull. It was noticed that the propeller had stopped turning, but that the engine continued working for several minutes after the capsize. The men holding onto the fadge used their legs to propel themselves towards the shore and away from the vessel.

1.1.11 The upturned hull drifted around the northeastern side of North Island, all the while settling lower into the water. When it started to drift away from the shore the men sitting on the hull decided to swim for the shore. During the swim the deckhand became separated from the former skipper and his nephew, but all three made it ashore onto Womens Island. The former skipper and his nephew landed on the eastern side of the island and climbed a track to the centre of the island where they came across a muttonbirder's hut, in which they found dry clothing and supplies. The deckhand landed on the northern side of the island, but was unable to reach the huts that were situated on the central upper plateau of the island.

1.1.12 Meanwhile the men attached to the fadge continued to drift towards the shore, but eventually the owner's friend became exhausted and succumbed. The owner decided that he could not make sufficient progress towards the shore while clinging to the fadge and so chose to swim for the shore, which he reached after clambering across kelp and rocks. He landed on the western side of Womens Island.

1.1.13 At about 1730 a ferry travelling between Bluff and Stewart Island came across a trail of flotsam about 2 miles to the northwest of North Island. The master alerted Stewart Island Fisherman's Radio, and from there an extensive search and rescue operation was mounted. Shortly after, the crew of the ferry saw lights on the southern end of Womens Island. The ferry was unable to get close enough to the island to either pick up the survivors or hear details of the accident. Another vessel, the *Wildfire*, arrived shortly after, and that vessel was able to get close enough for the skipper to talk with the survivors and get information about the nature of the accident and the number of people involved. That information was relayed to Stewart Island Fisherman's Radio and the local police officer.

1.1.14 A large number of vessels from Stewart Island, Bluff and Riverton joined the search and rescue effort, along with 2 helicopters and a fixed wing aircraft. At about 1930, one of the helicopters found the owner on the beach about halfway down the western side of the island and took him to Half Moon Bay, from where he was transferred by fixed wing aircraft to Invercargill and then to hospital. A little later the same helicopter picked up the former skipper and his nephew from near the muttonbirder's hut on Womens Island and took them to Half Moon Bay, where they spent the night. The fishing vessel *Reliance* found the body of the owner's friend in the sea to the southeast of Womens Island at about 2200. Although the search continued, no further survivors were found that night.

1.1.15 Early the following morning, Sunday 14 May, the body of the deckhand was found about 10 m up the rocky slope on the northern side of Womens Island. Later that day the wreck was located, and the body of the sister was recovered from the area. The fishing vessel that located the wreck marked it using fishing floats attached to heavy weights.

1.1.16 The next morning, Monday 15 May, a police dive team recovered the bodies of the father and the two 9-year-old children from the sunken vessel.

1.1.17 The wreck of the *Kotuku* was recovered the following week (see Appendix 4) and was taken via Port William, Stewart Island and Riverton to Invercargill for inspection.

1.2 Vessel information

1.2.1 The restricted limit fishing vessel *Kotuku* was built in Nelson by Curnow and Wilton in 1963. It was of wooden construction with kahikatea, commonly known as white pine, hull planking over birch frames with a rimu keel and deck beams. The vessel had a length overall of 14.2 m, a breadth of 3.96 m and a moulded depth of 1.54 m. The gross tonnage was 25.64 and the net tonnage was 14.99.

1.2.2 The engine, was a 6-cylinder in-line Caterpillar D333 diesel that produced 180 hp (134 kW), and drove through a MG 512 Twin Disc 4.4:1 ratio gearbox a fixed-pitch 4-bladed propeller, which gave a service speed of 8 knots. It was thought to be the original engine that had been fully rebuilt on at least one occasion.

1.2.3 When the *Kotuku* was built, coastal fishing vessels were not required to be built to a survey standard. However, there were survey circulars that prescribed international and New Zealand established practice for the design and construction of fishing vessels. A proposed consolidated set of design and construction requirements (the green book) was being circulated in 1963, but the first edition of the standards was not printed until 1965. The *Kotuku* was largely constructed to the proposed survey standard so that it could be brought into the survey system at a later date.

1.2.4 In 1966 the vessel was brought into the survey system and in December of that year an interim certificate of survey was issued. In February 1967 a certificate of survey for a coastal fishing vessel was issued.

1.2.5 The vessel was originally fitted with 3 non-watertight bulkheads, one forward of the engine room, one between the engine room and the fish hold (freezer) and the other between the fish hold and the steering gear compartment (net locker) (see Figure 3). In 1968, a watertight collision bulkhead was erected in the forepart of the vessel to comply with survey requirements.

1.2.6 An owner of the *Kotuku* in the early 1970s said that he had great confidence in the vessel, but on one occasion the autopilot had stuck hard to port causing the vessel to heel severely to starboard, almost submerging the starboard bulwark. He was able to disengage the autopilot and centre the helm, which allowed the vessel to return to the upright.

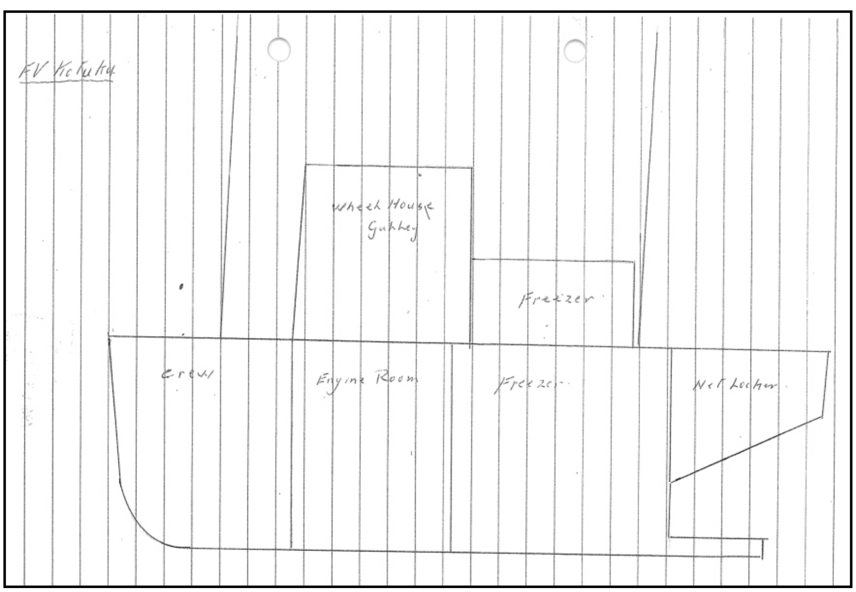


Figure 3
Original profile drawing of the *Kotuku*

1.2.7 Over the years, the vessel had been used for many types of fishing, including crayfishing, dredging for scallops and oysters, trawling and trolling. The original vessel had a large deck structure above the fish hold aft of the wheelhouse; this was referred to as the coach house (see Figures 3 & 4).

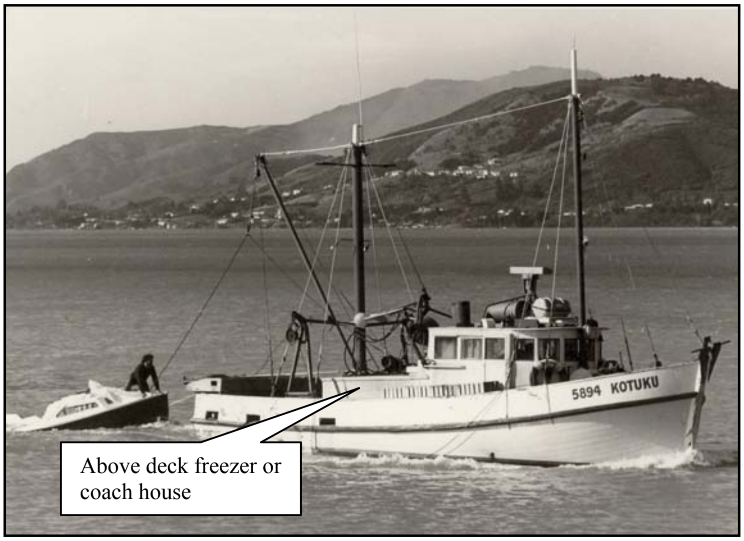


Figure 4
***Kotuku* circa 1973**

1.2.8 In 1988, after a particularly rough voyage, the *Kotuku* took on water and sank while it was lying at its mooring in Greymouth. The repairs necessary to restore the refloated vessel were expanded to include a major overhaul and refit of the vessel. The coach house was removed, primarily because there was decay in its superstructure. The main engine was removed and reconditioned, and the fuel tanks originally located in the fish hold were moved to the steering gear compartment and the engine room. The reconditioned engine was reinstalled, and the bulkhead between the engine room and the fish hold was re-established. Deck supports, flush decking and a hatchway were established where the coach house used to be. The fish hold was fitted out with new insulation and pond boards. All the fixed bilge and water pipes were replaced with stainless steel pipework. A gantry with an "A" frame above it was established at the after end of the vessel in lieu of the mast and derrick that were originally fitted (see Figure 5).

1.2.9 At the completion of the refit, the shipwright's report included a number of items that would need attention in the future. The report stated (in part):

> Bulwarks starboard side wheel house should have an eye kept on it as its not one hundred percent, keel-cooling forward. Packing blocks and hull should be looked at from time to time. **Hull in good order apart from being pickled with salt water. 5 months on the blocks and it never ever dried out** [emphasis added].

Despite, or possibly because of, the saturation of the wooden hull planking by sea water, the wood was described by the owner at the time of the refit as "well preserved". The starboard side bulwark mentioned in the shipwright's report was replaced in November 1990, at which time a shower and toilet compartment was established behind the wheelhouse.

1.2.10 Since 1994, when the present owner bought the vessel, a number of modifications had been made. These included:

- a net roller was installed on the gantry between the legs of the "A" frame soon after its purchase
- in January 2003 stabilising paravanes or "flopper stoppers" and their arms were added to each side of the gantry
- in 2004 the owner replaced the 24-volt submersible bilge pump that was connected to a float switch
- the original worm gear steering system was replaced in August 2004 by a full hydraulic system powered by a pump driven by a take-off on the port side of the main engine. A small hydraulic steering oil tank was added near the forward port side of the engine room
- also in 2004, the engine room port side fuel tank was removed. In addition, 2 fresh water tanks were installed against the hull on the port side
- in November 2005 the utility winch that was used to lift the catch on board, which was located behind the accommodation, was removed and replaced by a small winch fitted on the forward end of the gantry.

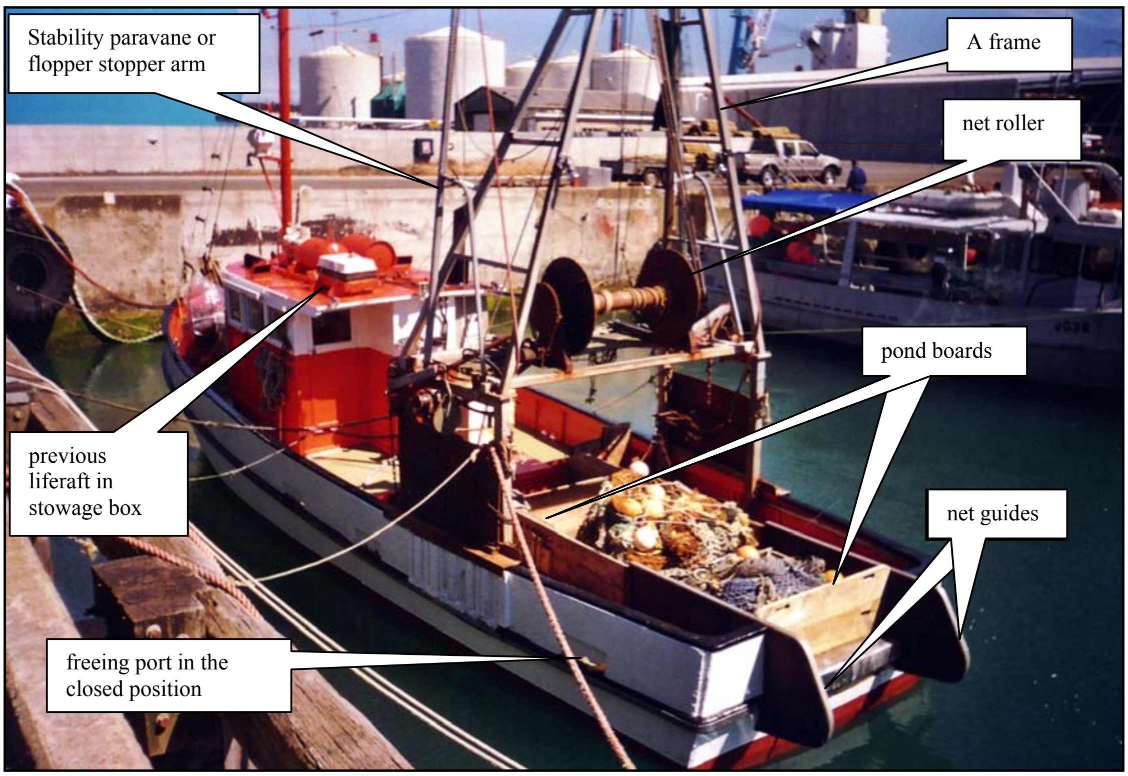


Figure 5
Afterdeck of the *Kotuku* in 2005

1.2.11 The net effect of the modifications over the years was to raise the centre of gravity of the vessel, increase its displacement and increase its trim by the stern. For example, the gantry that replaced the mast and derrick was of substantial construction and therefore added weight above the decks, and the net roller and accompanying net was additional weight, again well above the centre of gravity.

1.2.12 In 2004, the owner, due to ill health, put the *Kotuku* up for sale and listed it with 2 shipbrokers, one from Bluff and the other from Auckland. The latter asked 2 shipbrokers based in Picton and Nelson, one of whom had skippered the *Kotuku* in the 1970s, to assist with the sale of the vessel. Before they listed the vessel the Picton and Nelson shipbrokers had the opportunity to visit and inspect the vessel in Bluff. They said that they found the *Kotuku* was generally untidy, but also that it was wet inside, smelling of the mildew and mould that flourishes in closed moist spaces, particularly on wet wooden vessels. Consequently, they declined to promote the sale of the vessel. The Auckland shipbroker later said that in his opinion the vessel was sound, but was not as cosmetically well presented as he would have liked. The shipbroker from Bluff later said that he could not see anything wrong with the vessel; it was just a working vessel that needed tidying.

1.2.13 The shipwright who assisted the recovery of the vessel and assisted in the early inspections and gathering of samples on 12 June 2006 was asked to provide a report on its condition. In his report dated 3 July he indicated that the majority of the hull was sprung, but that it was almost impossible to determine if the hull had been sprung before the sinking. Due to the softness of the planking that allowed a screwdriver to be pushed into the timber, he was of the opinion that the hull planking of the vessel had been saturated for some time. He noted that the majority of nails that he had extracted from below the waterline were corroded, a factor he linked to the hull planking being saturated, given that fastenings in dry timber are not prone to corrosion. He also commented that the fastenings were still holding the planks onto the ribs, but being weaker they could allow the planks to move or ultimately spring in big seas. On 15 October 2007, in a letter to the solicitor for the vessel owner, he indicated that he felt the number of fastenings upon which he had based his earlier opinion was insufficient to give a representative sample. He went on to say that "I believe the *Kotuku* was in an acceptable condition and fit to go to sea. Its hull was normal for a boat of her age".

1.2.14 In light of the corrosion in the fastenings that were extracted on 12 June 2006, the same shipwright was requested to draw more fastenings from both the underwater and above-water hull at 5 longitudinal positions along the hull. He was also asked to take hull planking core samples from areas close to where the fastenings had been removed. On 15 August hull planking core samples were taken from below the waterline in the forecastle, the engine room, fish hold and steering gear compartment. A total of 16 planking fasteners were taken from above and below the waterline at the forecastle, above and below the waterline at the engine room and below the waterline at the fish hold. The average percentage wastage of those fasteners was 32%. In addition, 4 dumb drifts were removed from floors in the forecastle.

1.2.15 Another experienced boat-builder, boat designer and shipwright was asked to examine the hull planking core samples and fastenings taken on 15 August, together with those fastenings removed at the earlier inspection. He concluded the following:

- the hull planking was untreated kahikatea of 35 millimetres (mm) in thickness. The wood was not heart timber
- the inner surfaces of the hull planking were largely unprotected by paint coatings and showed various signs of surface decay, which was most likely due to inadequate ventilation
- all of the samples indicated that the timber was saturated
- a sample that weighed 36 grams was placed in a microwave oven for 2 minutes to remove the moisture. The dry weight was 4.2 grams, a loss of almost 32 grams of moisture (88% of its original weight)[1]
- all the sample fastenings showed varying degrees of wastage due to corrosion
- fastenings from aft of the engine room were corroded to the extent that they offered little or no holding power.

In summary, he commented that, if the samples were representative of the condition of the vessel, it should not have passed survey and would be unseaworthy and liable to spring a plank in a seaway.

1.2.16 Kahikatea was a timber commonly used for boat-building, particularly where the more popular kauri was unavailable. A technician at a New Zealand and Australian forestry research organisation summarised the properties of kahikatea as:

- it was a light and easy–to-work timber that was available in long clear lengths
- the sapwood and heartwood were not durable in ground contact and were not known to be resistant to marine borers, but heartwood may be moderately durable away from ground contact
- the sapwood was dimensionally unstable, whereas the heartwood was moderately stable
- the sapwood was permeable to water, and the heartwood was resistant to water penetration
- the better stability, resistance to moisture absorption and durability of kahikatea heartwood would have made it reasonably acceptable for boatbuilding
- the use of kahikatea sapwood for boatbuilding appears to be associated more with its low density, machinability and availability in long clear lengths, than with other special characteristics.

Kahikatea trees grown on hills have about 30% heartwood, but those grown in the lowlands and swamps have very little.

The technician said that in his experience there was no separation of sapwood and heartwood during the milling process. From that it would be expected that a boat builder may not have had the opportunity to choose whether he used heartwood or sapwood.

[1] The test dried the wood until all moisture in it had evaporated. Further heating resulted in auto-combustion. Naturally seasoned timber has a moisture content of about 15%.

1.2.17 In response to submissions to the preliminary report, the Commission engaged the shipwright referred to in paragraph 1.2.15 to inspect the hull of the *Kotuku* and remove and examine a larger sample of hull fastenings. Appendix 9 has a full account of the inspection on 29 and 30 October 2007, but a summary of findings was as follows:

- the fastenings showed varying degrees of corrosion. The average measured wastage was 26% on the port side and 20% on the starboard side, slightly less than the sample taken on 15 August 2006
- the condition of the caulking was less than optimal
- hull planking under the aft starboard sheathing showed signs of decay
- there was decay in a butt block in way of the forward accommodation. The detail of the butt blocks was such that they would hinder the rapid and complete clearance of water
- the general condition of the vessel reaffirmed the conclusions reached by the shipwright from the samples taken on 15 August 2006
- all grades of kahikatea, from yellow heartwood, through paler medium young heartwood to light whitish sapwood, had been used in the hull planking, but sap timber did predominate.

1.2.18 The vessel was fitted with the following navigation and communication equipment at the time of its capsize (see Figure 6):

- a Furuno FR 711 radar
- a Furuno FCV 582L echo sounder
- a Furuno GP 1250 GPS/plotter
- a Furuno GP32 GPS
- a Uniden MC 780 VHF radio
- a magnetic compass
- a Coursemaster 050 auto pilot
- a GME S/NCM01108 emergency position indicating radio beacon (EPIRB). Battery expiry date November 2009.

1.2.19 In November 2005 the vessel was slipped for an out-of-water survey. At that time the following lifesaving and fire fighting equipment was recorded:

- an RFD Pacific-4 4-person liferaft, manufactured in September 2004. The liferaft was last surveyed on 21 October 2005. A Salcom MRB2 EPIRB was packed into the liferaft
- a Hammar H2O hydrostatic release unit (HRU) to secure the liferaft. Expiry date October 2006
- 2 lifebuoys, one with a line and the other with a light
- 3 lifejackets with lights and whistles
- an engine-driven pump that provided water for fire fighting or could be used to pump the bilges
- 4 parachute flares. Expiry date February 2007
- 2 buoyant smoke floats. Expiry date June 2007
- 3 portable fire extinguishers. Service date October 2006
- 2 fire buckets
- A fire axe.

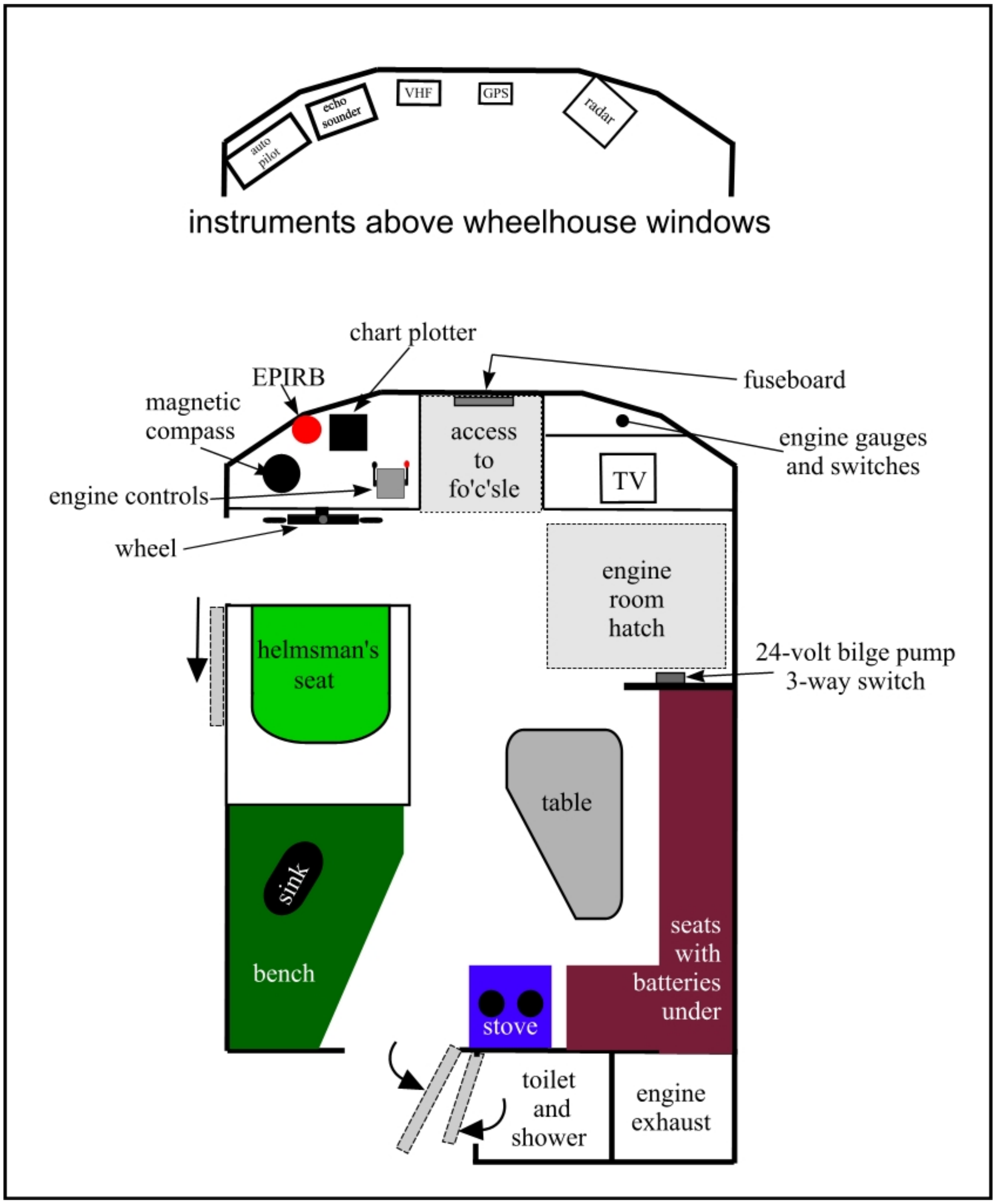


Figure 6
Wheelhouse layout

1.2.20 The primary bilge and deck wash system was operated by a Renown main engine belt-driven pump that was rated at 25,000 litres per hour at 3250 rpm (see Figure 7). The pump was later tested and a flow of 18,000 litres per hour was achieved at 1400 rpm. The drive belt was connected directly to the main engine and so pumped continually when the engine was running. The system was generally set up to draw seawater through the sea suction and discharge it via the deck wash hose (see Figure 7). To pump the bilges the valves needed to be set to close the sea suction and to draw from the engine room or fish hold, the discharge being through the deck wash hose. The valves to the fish hold or engine room bilges were not of the non-return type and so would not prevent back flooding through the bilge system.

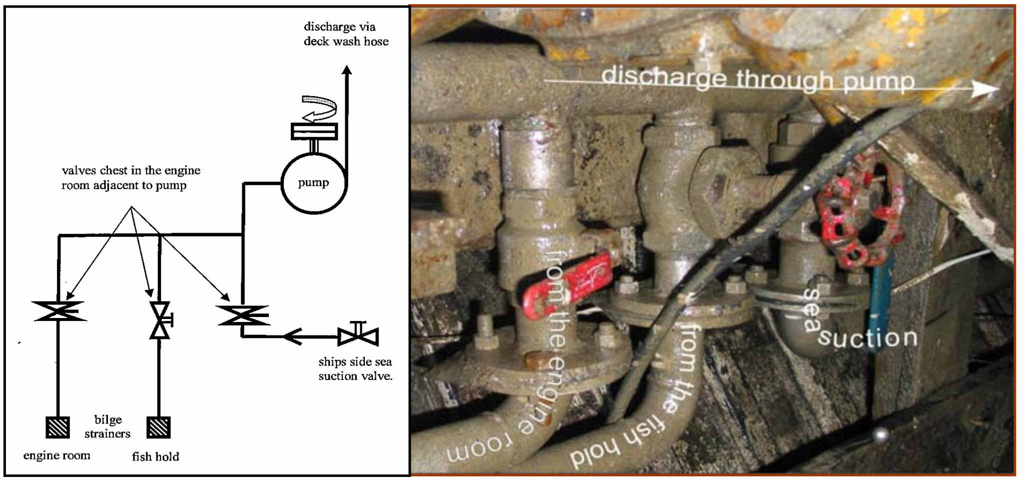


Figure 7
Bilge system diagram and photograph

1.2.21 A sink in the wheelhouse, which appeared to be original, had a drain that discharged through a skin fitting on the after port side of the engine room, about 300 mm above the waterline. No non-return valve was required or fitted to the drain. At some time in the life of the vessel a second bilge pump was installed in the fish hold; a 24-volt, submersible, with an automatic float switch located in the engine room bilge. The discharge for this pump was connected into the sink drain by a "T" joint.

1.2.22 When the vessel was recovered, the wiring for the 24-volt submersible bilge pump and associated float switch was found to be in poor condition. The pump was controlled by a domestic 3-way electric switch, which was mounted low on the panel forward of the bench seat on the starboard side of the wheelhouse, next to the engine room entrance. The switch moved horizontally and its positions were:

Starboard	**on**	bilge pump operated continuously
Centre	**off**	bilge pump was isolated
Port	**auto**	float switch controlled the operation of the bilge pump

After recovery of the vessel, the switch was found in the centre, or off, position. One of the wires from the switch was found disconnected; this was later identified to be the connection on the automatic side of the switch. The wiring between the pump, the float switch and the battery was joined by a non-weathertight connector in the propeller shaft recess.

1.2.23 The 24-volt bilge pump, float switch, control switch and associated wiring were removed from the vessel. A marine electrician inspected and tested its operation and drew a circuit diagram (see Figure 8), finding:

The control switch had no continuity reading, the terminals were cleaned with a wire brush, but still no continuity. The switch was opened and severe corrosion, green fur probably from immersion in salt water and then exposure to air was found. The wiring to the switch was intact except for the return wire from the float switch, which was found clear of the terminal with the wire stiff with similarly stiff and broken insulation. There was a small piece of insulation tape attached to the end of the wire.

The float switch was tested for continuity and found to be operating correctly.

The 24-volt pump was wired to 2 x 12-volt batteries and found to be working correctly.

The float switch was wired into the circuit, using additional wiring where necessary, and operated the pump correctly.

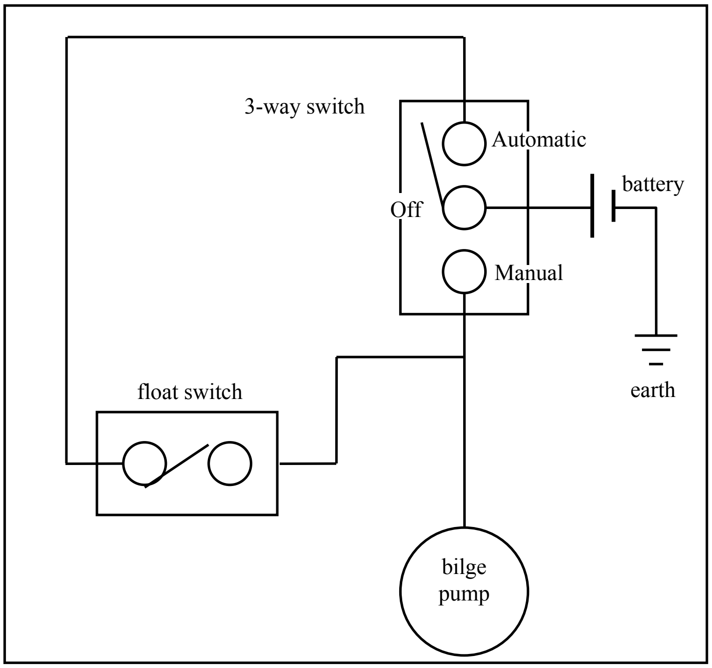


Figure 8
Circuit diagram of the 24-volt bilge pump and float switch

1.2.24 Had the 24-volt bilge pump been the primary bilge pumping system it would have been required to meet the requirements of Maritime Rule Part 40D (Design, Construction and Equipment – Fishing Ships) (Part 40D) 28(6)(c) and (d), which stated:

> (c) each submersible bilge pump is to be fitted with a float switch which automatically operates that pump or an audible alarm at the steering position. Any such float switch is to be protected from jamming by bilge debris; and
> (d) each submersible bilge pump is to have a visual alarm at the steering position to indicate when it is running.

However neither the owner or the respective surveyors considered, the 24-volt bilge pump to be the primary system and it was not made to comply with the above requirements.

1.2.25 The owner said that at Kaihuka he had gone down into the engine room and while there had run the 24-volt bilge pump in the manual mode. None of the crew could remember, nor were there any records of when the float switch was last tested or when the pump was last operated in the automatic mode.

1.2.26 The height of the afterdeck bulwarks was 580 mm on the port side and 540 mm on the starboard side. Part 40D.22(3) stated that the minimum height of bulwarks and guardrails on ships of less than 24m in length was required to be 750 mm, except that where they interfere with fishing operations a surveyor may allow them to be of a lesser height, but not less than 450 mm. The aft part of the afterdeck between the bulwarks was partitioned by pond boards that allowed fish to be landed, sorted and cleaned before being stored in the fish hold (see Figures 5 and 9). The pond boards were almost flush with the deck and of a height slightly lower than that of the bulwarks and net guides.

1.2.27 The transom of the vessel had 2 fixed vertical longitudinal boards that were used to guide the net onto the deck when it was being hauled. The pond boards extended forward from these net guides to athwartship boards fitted between the fish hold hatch and the bulwarks. The pound area formed by the longitudinal boards was divided into 3 sections by athwartship boards. The aftermost of the athwartship pond boards was the same height as, and was situated between, the net guides to stop following seas washing onto the afterdeck (see Figure 5).

1.2.28 There were 7 rectangular freeing ports along the length of the afterdeck (3 on the port side and 4 on the starboard side) (see Figure 9). Each freeing port was fitted with a vertically sliding cover, which had jamming wedges at the top to allow the covers to be held in the open position. The covers were made of plywood or aluminium. Each of the covers had small cut-outs along their lower edges, triangular in shape on the aluminium covers and half-moon shaped on the plywood ones. The freeing ports were of differing sizes and varied between 495 mm x 170 mm and 520 mm x 210 mm. The total available freeing port area when the covers were fully open was 0.66 m^2. Part 40D.23(1) prescribed a formula to calculate the minimum freeing port area. Using the formula the *Kotuku* required a total freeing port area of 0.4 m^2. The cut-outs in the freeing port covers provided a freeing area of about 0.04 m^2

1.2.29 Part 40D.23 specified that (in part):

> (6) …If fitted, the construction of freeing port covers must be approved by the surveyor. Sliding covers must not be fitted and no locking devices must be fitted to hinged covers.
>
> (7) The master must ensure that freeing ports are maintained and kept free of any obstruction or means of permanent closing when the ship is at sea.

1.2.30 During the trip, the end of the deck wash hose, which pumped continuously when the engine was running, was jammed under one of the cut-outs in the after port side freeing port cover so that it discharged directly over the side. The forward starboard freeing port had the discharge hose for the toilet jammed under a cut-out in its cover. Evidence suggested that it was usual practice to operate the vessel with the freeing port covers in the down or closed position.

1.2.31 The crew usually stowed empty fish cases between the starboard bulwark and the wheelhouse, and on the starboard side of the afterdeck up to the forward pond board, as shown in Figure 9. On the accident trip, the owner estimated that there were about 50 empty fish cases stowed in those areas.

1.2.32 The owner suggested that the fault with the throttle controls, noticed on the trip between Bluff and Half Moon Bay, was repaired on the afternoon of 12 May. However, evidence indicated that the knife was still being used to wedge the throttle on 13 May. Police divers were the first to observe the wreck; they reported that the throttle controls were in the idle ahead position. Later inspection showed that the throttle lever would not remain above the idle ahead position once the pressure on the lever was released. After the capsize, one of the survivors who climbed onto the upturned hull noticed that the propeller had stopped turning, but the engine continued to run for several minutes. The Twin Disc gearbox used an integral oil pump to provide hydraulic pressure to keep the clutch plates engaged. Loss of hydraulic oil pressure resulted in the clutch disengaging. When the vessel capsized, the gearbox became inverted, causing a loss of suction on the oil pump, the clutch to disengage and the propeller to stop turning.

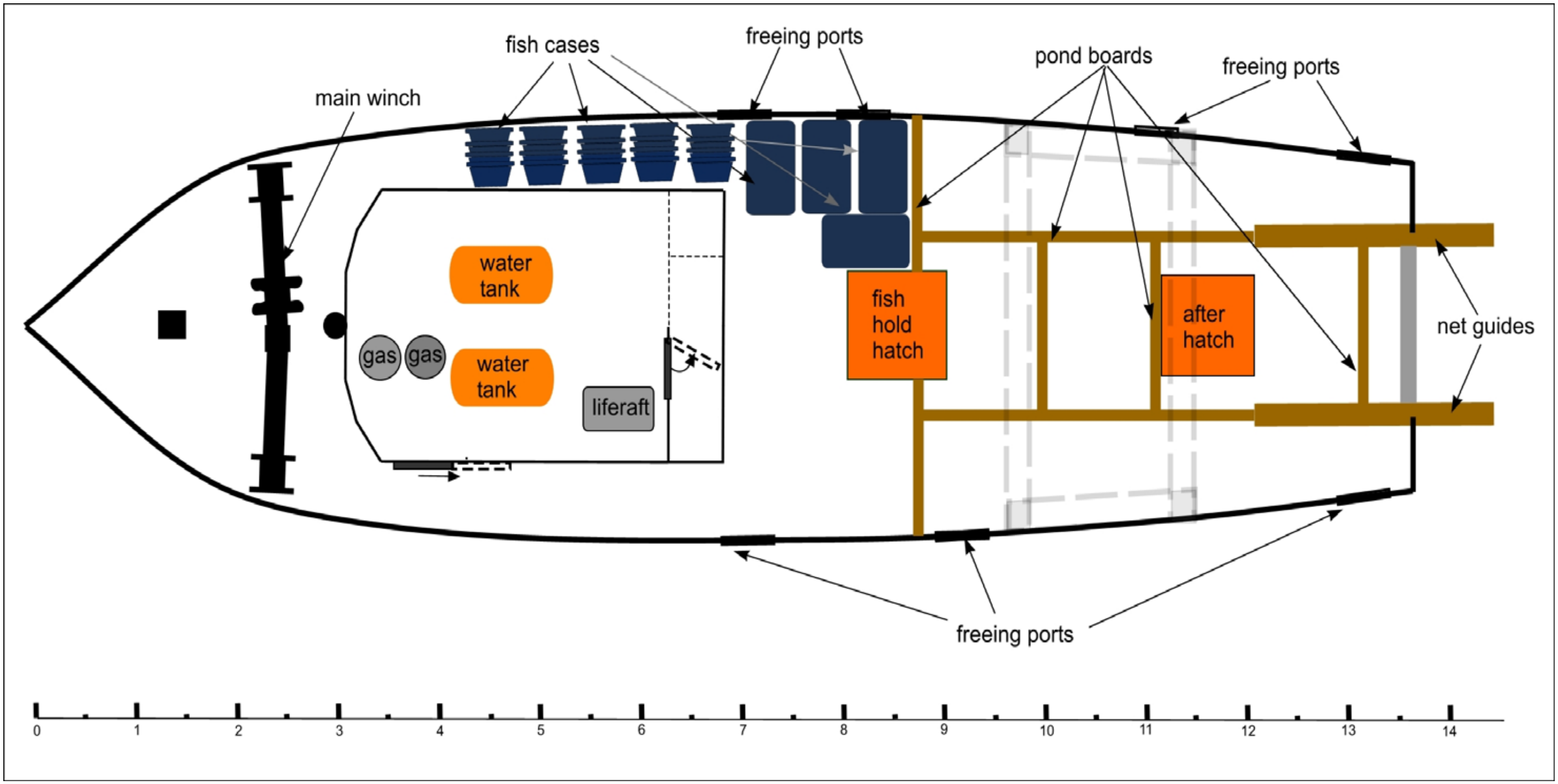


Figure 9
Plan of the *Kotuku*, approximately to scale

1.3 Analysis of the construction and fit-out of the *Kotuku*

1.3.1 The *Kotuku* was an established fishing vessel. It had been involved in many fisheries and had operated in some of the most inhospitable waters around the coast of New Zealand, including the exposed west coast with its bar harbours, the Chatham Islands and the waters of Foveaux Strait. It was extraordinary that such a vessel could capsize so suddenly in weather conditions that were considerably better than some in which it had operated.

1.3.2 When the *Kotuku* was built there were only draft guidelines governing the design and construction of fishing vessels. The vessel was not required to be built under a surveyor's supervision but, because the owner at the time of building decided that he would want to put the vessel into survey at a later date, he had the vessel built to the standards of the day under the supervision of the local Marine Department (the predecessor to Maritime New Zealand (Maritime NZ)) surveyor.

1.3.3 There were no plans or scale drawings of the vessel. At that time, it was customary to build a vessel to a standard hull design, which was adapted to meet the owner's requirements. In 1963, except for a collision bulkhead, watertight segregation was not required for coastal fishing vessels. The *Kotuku* was built without any transverse watertight bulkheads, but a collision bulkhead in the bow of the vessel was retrofitted. The minimal watertight segregation meant that should the watertight integrity of the vessel be breached, water could freely spread throughout almost the entire length of the vessel, potentially allowing a large volume of water to collect in the bilges before it was detected.

1.3.4 The design and construction of fishing vessels had improved significantly in recent years, with revised standards, regulations and rules. The most recent legislation, Part 40D, was only partly applied to existing ships. Consequently, there was a sizeable population of operational fishing vessels that were built before maritime rules came into force and that did not have the benefit of the current design standards.

1.3.5 The sinking of the *Kotuku* at its mooring in 1988 was not investigated nor was the cause established, but the owner at the time thought it was probably due to a hull plank coming loose during a rough voyage that they had just completed. Significant decayed wood was discovered in the fish hold area, so the owner took the opportunity to modify and improve the superstructure, engine room and fishing equipment at the same time as the flooding damage was being addressed. The shipwright's report on the work he had done identified the areas he had repaired and also those that would need attention in the future.

1.3.6 The *Kotuku* was constructed of kahikatea, a common boat-building timber that was quite light and often used when kauri was not available. The wood, particularly the sapwood, was known to absorb water readily. On this occasion, the vessel was on the sea bottom at a depth of over 30 m for 10 days and during that time a pressure of about 4 bar would have forced water into the wood, and so it would be expected to be saturated when it was recovered. However, there was no evidence that the saltwater saturation of the hull noticed by the shipwright in 1988 had diminished in the years before the capsize and sinking. The condition of the hull planking and the wasting of the fastenings, together with the dampness mentioned by the 2 shipbrokers in 2004, indicated that the hull was wet before the capsize. Saturation of the hull planking would have caused it to swell, paradoxically tending to make the hull more watertight. The additional weight through the saturation would have resulted in an increase in the displacement of the vessel with a corresponding reduction in its freeboard. The statical stability of the vessel would have been marginally improved due to the increased weight being primarily below the centre of gravity, but the range of stability would have been reduced due to the earlier submersion of the deck edge.

1.3.7 The decay found in the hull planking would have compromised the watertight integrity of the vessel. On inspection, the shipwright considered it unlikely that the hull was entirely watertight, and he was of the opinion that the vessel would have made water continuously, although the extent of the ingress could not be quantified.

1.3.8 Saturated hull planking promotes electrolysis to act upon the fastenings. A number of the *Kotuku* fastenings were found to be wasted, which would have allowed the vessel timbers to move, eventually leading to the separation of the hull planks from the inner structural members of the vessel. The condition of the recovered hull was such that it could not be determined whether any planks had moved before the capsize, but such an event could not be discounted and would have led to an accelerated ingress of water into the hull. Any water in the bilge would have a similar effect on the statical stability of a vessel as the saturation of the hull planking described in 1.3.6, with the additional virtual loss of stability through free surface effect.

1.3.9 When the *Kotuku* capsized and sank it was a significantly different vessel to that built in 1963, having undergone many modifications and equipment changes over the years. There was no evidence that any of the modifications had been inspected and approved by either the incumbent maritime authority inspectors or, in later years, safe ship management (SSM) company surveyors. This was corroborated by other information obtained by the Commission indicating that it was not uncommon for owners and engineering companies to carry out major repairs and modifications without notifying either the SSM company or Maritime NZ.

1.3.10 Similar to many other fishing vessels, the modifications made to the *Kotuku* had generally resulted in weight being added or moved upwards, often well above the centre of gravity of the vessel. The resulting upward movement of the centre of gravity reduced the righting lever, which reduced the ability of the vessel to return to the upright position after being heeled.

1.3.11 The engine-driven fixed pump was designed to provide the primary bilge pumping system, but it was rarely used for that purpose, being almost exclusively used to provide deck wash water. The bilges were routinely pumped using the 24-volt submersible pump. This was a more convenient way to pump bilges, particularly where small quantities of water were involved, but it did deny the operator the practice of using the primary bilge system. Arguably, because the way the bilge systems were being operated, the 24-volt bilge pump became the primary means of pumping the bilges, but it did not meet the provisions of Part 40D 28 Bilge pumping arrangements.

1.3.12 The 24-volt submersible bilge pump was replaced by the owner in about 2004. The design of the pump and float switch was such that they could be submerged while retaining their watertight integrity. The electrical supply cable attached to the pump was of sufficient length for it to be connected to the electrical system of the vessel above the bilge, but on the *Kotuku* a non-watertight joining block in the propeller shaft recess had been used. Consequently, had the vessel taken on water and the propeller shaft recess become flooded, the 24-volt submersible pump would have failed due to an electrical short at the joining block.

1.3.13 One of the crew said that about 30 minutes before the capsize, he thought the 3-way switch on the 24-volt pump had been bumped from the auto position to the off position by one of the other people on board. So, without checking whether there was water in the engine room bilge, he flicked the switch to the starboard, or on, position. The action of starting a pump and leaving it running without first checking that there was water in the bilge seems to be unusual, and ran the risk of damaging the pump by running it dry. The owner said that he had run the pump in the manual mode on the morning of the accident, but no one could remember when it had last operated in the automatic mode. An indicator light in the wheelhouse would have been a good way to show that it was working, as well as indicating to the crew that there was water in the vessel; and, if this had been the primary bilge pump, such an indicator light would have been required by Part 40D. A bilge pump is a critical piece of equipment that should be tested regularly in all modes of operation. There was no record that the electric bilge pump was tested in automatic mode on the *Kotuku*.

1.3.14 When the vessel was recovered the 3-way switch was found in the centre, or off, position. It is possible that the switch may have been knocked during the capsize or recovery. Alternatively, it is possible that the switch was not knocked into the off position as the crew member thought, and that it was then moved by the crew member the off position, thereby unintentionally turning the pump off.

1.3.15 The discharge pipe from the 24-volt pump was connected to the drain from the sink, which discharged through the hull about 300 mm above the waterline. Neither the drain line nor the pump had a non-return valve, so it was possible for water to backflow into the hull through that skin fitting and pipework. However, with the skin fitting being above the waterline and of a small diameter it would be unlikely to have allowed sufficient water to enter the hull to cause the down flooding or destabilisation necessary to bring about the capsize of the *Kotuku*.

1.3.16 Water-cooled propeller shaft stern glands are designed to allow a certain amount of water to seep through the gland to provide lubrication and cooling. Wooden vessels can also suffer seepage through the joints in the hull planking. The *Kotuku* was both wooden and had a water-cooled stern gland and so would be expected to make some water. The crew indicated that they needed to pump the bilges approximately once every 2 or 3 days, which would indicate a realistic rate of seepage from these sources alone. However, the condition of the planking may have been allowing additional water ingress that would have required more frequent pumping from time to time.

1.3.17 The maritime rules in place at the time of the accident required bilge alarms to be fitted only where an engine room was an enclosed watertight compartment; the *Kotuku* did not have such an engine room and was not required to be fitted with such an alarm. Although not required by the maritime rules, bilge alarms are a cost-effective and effective early warning of unexpected water in the hull that could disable the propulsion or electrical machinery and in particular the pumps necessary to evacuate the water. Many surveyors require both bilge alarms and bilge pump warning lights to be fitted to all vessels, even where the engine room is not an enclosed compartment. Without a bilge alarm a considerable amount of water could accumulate in the bilge of a vessel before it was noticed.

1.3.18 The problem with the throttle lever mechanism appeared to be still present during the homeward journey. The knife used to jam the control did not keep the throttle lever in the full ahead position, but allowed it to fall back and come to rest at a position where the vessel was able to make 5 or 6 knots; the crew said they were satisfied with this speed and left the lever in that position.

1.3.19 Any slowing of the engine would have reduced the effectiveness of the helm and made it more difficult to counter any course variation caused by the sea before and during the capsize sequence. The first diver onto the vessel found the engine controls in the idle ahead position, but this was not conclusive proof that the engine had slowed before the capsize because it is almost certain that the knife would have fallen out when the boat became inverted; also, the controls could well have been knocked during the capsize event.

1.3.20 The total freeing port area met the minimum size requirement for a vessel such as the *Kotuku*. However, with the sliding covers in the down, or closed, position, as they usually were, the freeing area was only about 10% of that required. Additionally, the free flow of water from the deck was further restricted by the fish cases stowed on the starboard side and the pond boards on the afterdeck.

1.3.21 Vertically sliding freeing port covers were specifically mentioned in the maritime rules as being unsuitable, which should have been noticed during SSM fit-for-purpose inspections and a corrective action issued, but this was not done. The same maritime rules required that the master of a vessel maintain clear freeing ports, but this was not done on the accident voyage.

1.3.22 Freeing ports are essential for the rapid removal of water from the deck. It is not uncommon on low freeboard vessels to have waves break over the bulwarks. If the water was not shed from the decks quickly, rapid destabilisation could occur. This likely factor in the capsize and sinking of the *Kotuku* is discussed later in the report.

1.4 Personnel information

1.4.1 The owner of the *Kotuku* had been fishing for most of his adult life, starting work in the oyster fishery in about 1970. He gained a second-class diesel trawler engineer certificate in March 1980 and a skipper of a coastal fishing vessel certificate in May of that year. He had been skipper on a number of vessels engaged in trawling and dredging for oysters. He purchased the *Kotuku* in 1994 and had initially fished out of Timaru and then in later years had worked out of Bluff. During the last 2 years he had employed others to fish the *Kotuku* for him.

1.4.2 The deckhand had fished in both the oyster and inshore trawling industries, but did not hold any maritime qualifications.

1.4.3 The friend of the owner did not have any maritime experience other than recreational fishing trips in and around Foveaux Strait.

1.4.4 The father of the former skipper had many years of experience operating fishing and pleasure vessels in and around Foveaux Strait. He had taken part in muttonbirding for almost all of his 78 years, formerly at Big South Cape Island off the southwest corner of Stewart Island and later at Kaihuka on the south-eastern side of Stewart Island. He held a skipper of a coastal fishing vessel certificate and a second-class diesel trawler engineer certificate, and had extensive knowledge and experience of the topography and the weather and sea conditions that could be expected in the area. The father had steered the *Kotuku* previously, but at that time it had the original worm gear steering rather than the new hydraulic steering system that was in place at the time of the accident.

1.4.5 On this occasion the father had not taken part in the muttonbird gathering, but had only decided the previous evening to travel down to Kaihuka on the helicopter that was being used to transfer the cargo between the island and the vessels.

1.4.6 The former skipper had been fishing for over 20 years out of Bluff, Greymouth and Jacksons Bay. He had gained an inshore skipper certificate in 1982, and Maritime NZ records note that the certificate was endorsed for him to operate the fishing vessel *Xavier* in area 27 (the Foveaux area in the vicinity of Stewart Island). From the beginning of 2006 until he went muttonbirding on 20 April, he had been skipper of the *Kotuku*.

1.4.7 The sister and children were used to travelling on vessels on their visits to the muttonbird islands.

1.5 Legislation

History of maritime survey in New Zealand

1.5.1 The New Zealand maritime industry had been overseen by various government agencies since 1862. Initially it was the Chief Marine Board, which became the Marine Department and then was incorporated into the Ministry of Transport as the Marine Division in 1972. In 1988 it was renamed and restructured as the Maritime Transport Division of the Ministry of Transport. In 1993, the Maritime Safety Authority was established as a Crown Entity under the transition legislation of the Maritime Transport Act 1993. The Maritime Safety Authority was charged with administering the new Maritime Transport Act 1994 when it came into force in February 1995. On 1 July 2005, the Maritime Safety Authority was renamed Maritime New Zealand.

1.5.2 The Shipping and Seamen Act 1952, which was supported by regulations, formed the basis of maritime legislation until 1994 when the Maritime Transport Act came into effect. Under the Shipping and Seamen Act, vessels were surveyed and certified annually by surveyors employed by the incumbent maritime agency. From its inception, the Maritime Transport Act 1994 was intended to be supported by maritime rules; however, those rules took time to write and enact. So there were transitional provisions to allow the regulations and parts of the Shipping and Seamen Act 1952 to remain in force until the appropriate maritime rules were enacted.

1.5.3 The change from the Shipping and Seamen Act 1952 being supported by regulations to the Maritime Transport Act 1994 being supported by maritime rules was an effort to streamline the legal framework. However, since the beginning the maritime rules have been subject to delay for one reason or another. When it was deemed that a new rule or an amendment was necessary, the draft rule was written and made available to interested parties for consultation as required by section 446 of the Maritime Transport Act. Maritime NZ then considered any submissions before the final rule was presented to the Minister of Transport for signature. The rule came into force 28 days after it was promulgated in the *New Zealand Gazette*. This process has resulted in new maritime rules and amendments to existing rules taking longer than anticipated. Many new maritime rules and amendments to existing rules that were scheduled to be brought into force during the year 2002/2003 were still to be published, and in some cases had not reached the circulation for comment stage, at the time of writing.

1.5.4 As part of the new legislation, Maritime Rules Part 21 (Safe Ship Management Systems) (Part 21) came into force in 1997. The SSM system was based on the established International Safety Management System, but was modified for domestic commercial ships. Part 21 was supported by an included New Zealand Safe Ship Management Code, which outlined how an SSM system should be implemented. Since 2001, Maritime NZ has been preparing a revised Part 21, but that was one of the amendments still to be circulated for comment at the time of writing. In 2005, a Safe Ship Management Code of Practice was written, which set down requirements and responsibilities of participants in the system.

1.5.5 The philosophy of the SSM system was for owners and operators to take responsibility for their own safety and to develop their own safety management system in conjunction with their chosen SSM provider, and in so doing develop a safer working environment on their ships. Owners were required to develop a quality systems approach to managing safety on their vessels. At the time of writing there were 7 general SSM companies and one company that administered its own in-house SSM system. Part 21 provided a broad standard format of what was required of the industry, but the requirements were often interpreted differently by individual SSM companies, which resulted in disparity of standards across the industry. These disparities have been documented in several TAIC occurrence reports, 2 independent industry reviews commissioned by Maritime NZ and one audit of Maritime NZ in relation to the SSM system.[2]

1.5.6 The transition period, between 1993 and 1994, when the Maritime Safety Authority was formed, saw the devolution of the vessel survey function to a commercial limited company. Over the next few years more independent survey or SSM companies were formed, so that when Part 21 came into force there was commercial competition to provide the SSM function. In addition to the general SSM companies, 3 operators set up their own in-house system solely to provide the SSM function for their own vessels. With the advent of SSM in 1997 came the requirement for fishing vessels of less than 12 m in length and passenger vessels of less than

[2] Pacific Marine Management; Review of Safe Ship Management. February 2000.
Thompson Clarke Shipping Pty Ltd; Review of Safe Ship Management Systems. 23 September 2003.
Controller and Auditor-General; Maritime Safety Authority: Progress in implementing recommendations of the Review of Safe Ship Management Systems. December 2005.

6 m in length to comply with the rules; both classes of vessel had not been subject to legislation prior to that. Later, in 2000, a number of unique or smaller classes of vessel were allowed to operate under a Safe Operating Plan rather than an SSM system.

1.5.7 The 2 independent reviews and one audit of the SSM system that had been conducted since the commencement of the SSM system in February 1998 were as follows:

- In February 2000 an independent review that was commissioned by Maritime NZ concluded that: "In overall terms, the introduction of SSM has been beneficial, as is its continuation. The administration of SSM, by both the MSA and the SSM companies, is satisfactory, but there are several specific issues that need attention."
- In March 2002 a further independent review was commissioned by Maritime NZ. Maritime NZ received the results of that review in September 2002, which indicated that at that stage a significant number of difficulties with the SSM system had emerged. In December 2002 the Board of Maritime NZ approved the implementation of 11 of the 29 recommendations arising from the review and noted the remaining 18 recommendations. The Safe Ship Management Code of Practice was introduced on 1 February 2005, principally in response to many of the 2002 recommendations.
- In December 2005 the Auditor-General conducted a review of the progress made by Maritime NZ in implementing the recommendations from the March 2002 review. The Auditor-General found that Maritime NZ had adopted an appropriate approach to receiving and implementing the recommendations from the 2002 review. The Auditor-General was satisfied with the reasons Maritime NZ had not implemented all of the 29 recommendations, and made only 2 recommendations relating to communication and consultation procedures respectively.

1.5.8 Maritime NZ employed Maritime Safety Inspectors (MSIs) in the field to carry out random inspections of vessels. The *Kotuku* was last inspected on 18 February 2004 in Bluff; at that time no deficiencies were noted. However, since 2005 and as a result of the 2002 SSM system review, Maritime NZ had changed its approach and MSIs no longer inspected vessels; instead they carried out risk assessments during their visits. They had a target of visiting 25% of the fleet each year, or visiting each vessel at least once every 4 years.

1.5.9 Since 2000, Maritime NZ had sought to introduce a system to benchmark safety performance and to reflect the current state of a vessel, including its maintenance and operations. The system was designed to allow Maritime NZ to target the inspection regime on vessels in the higher-risk categories. The Safety Profile Assessment Number (SPAN) system had suffered some initial problems and had been reviewed and amended in 2003. The system in place at the time of the *Kotuku* accident used a number of elements to calculate the SPAN for each vessel. The primary element was a word picture, which was used to evaluate the general condition of a vessel and the way its SSM system was operating. Word pictures were a standard auditing procedure and helped provide a standard method of evaluation for all the vessels, irrespective of who carried out the inspection. The Maritime NZ word picture was used by MSIs, and by SSM surveyors and auditors during their inspections of vessels. The original word picture consisted of descriptions for 10 assessed areas, with multiple choice descriptions. To determine the SPAN the completed word picture was entered into a computer program and combined with other factors such as oil spill history, complaints, inherent risks and deficiencies from surveys.

1.5.10 The most recent SPAN for the *Kotuku* was based on a word picture completed during a survey by the SGS M&I surveyor on 23 November 2004. The resulting vessel score (see Appendix 7) ascribed no risk to the *Kotuku* other than the inherent risk of it being a fishing vessel which gave a SPAN of 7. Maritime NZ said that at the time the SPAN was calculated the computer program was giving unrealistic figures from the information that was being entered into it, occasionally generating a zero result instead of positive numbers. This resulted in vessels being assigned unrealistically low safety profiles during that period. To combat this problem, a new word picture was produced that had 11 assessed areas, with a total score of 100, against which an inspector could evaluate a vessel. It was this word picture that was used on 7 November 2005 by the same SGS M&I surveyor, in which the *Kotuku* attained a score of 53 (see Appendix 7). The surveyor did not take any further action, and neither did Maritime NZ issue a revised SPAN from this information before the vessel sank.

1.5.11 One of the 2005 changes to the word picture was to assign numerical values to each of the responses, which allowed a surveyor to produce a total score. In comment on the preliminary report the surveyor was of the opinion that the SPAN of 53 was to be considered as typical or only slightly worse than the general condition of the older and smaller boats in the New Zealand fishing fleet. Maritime NZ in comment on the preliminary report was of the opinion that such a SPAN number indicated a vessel of higher risk and as such the surveyor should have taken action to address that risk. The manual that accompanied the release of the 2005 system divided the SPAN into priority ranges:

Priority	SPAN
1	0-19
2	20-39
3	40-59
4	60-79
5	80-100

Ranges 1 to 3 (0-59%) were considered lower priority, while ranges 4 and 5 (60-100%) were considered high and vessels falling in that range were subject to increased inspections.

1.5.12 Prior to the introduction of the SSM system, the survey and inspection programme called for annual surveys, which checked the condition of the vessel and its equipment and followed a regular pattern. The 2- and 4-year surveys required the vessel to be out of water, with the 4-year survey requiring the inspection of the propeller shaft and rudder.

1.5.13 The inspection regime under SSM was a combination of surveys and audits. These were intended to assess the condition of the ship and the adherence to the safety management system by the owner, operator and crew. The audit and survey timing was:

- ship entered service and was inspected by an SSM surveyor, who issued an SSM exemption certificate (or provisional SSM certificate)
- within 3 months, an initial vessel audit was conducted; this was a systems audit to ensure the SSM system was working. Since 2005, this audit was carried out by Maritime NZ; prior to that it was conducted by the SSM companies
- at intervals not exceeding 2 years the ship was required to have an inspection of the hull and external fittings below the waterline with the ship out of the water. At intervals not exceeding 4 years, propeller shafts and rudder stocks with water lubricated bearings were required to be inspected. Other propeller shafts and rudder stocks could be inspected at intervals not exceeding 5 years
- the maritime rules required that an SSM provider audit the SSM system of a vessel, without specifying a time cycle. Maritime NZ interpreted this requirement to mean that an audit was required within 6 months either side of the 2-year out-of-water survey.

1.5.14 In April 2006 Maritime NZ appointed a specialised audit team to carry out regular safety audits of SSM companies.

1.5.15 The *Kotuku* had remained a commercial fishing vessel and been subject to survey inspections throughout its life. The *Kotuku* entered SSM when that system was established on 21 August 1997, and an SSM certificate was issued by M&I SSM company (the former name of SGS M&I) in October 1997. The certificate stated that the vessel was allowed to operate within 100 miles of the coast of New Zealand including Stewart Island and the Chatham Islands.

1.5.16 At the time of the accident, the vessel held a current SSM certificate that had been issued on 15 February 2006 and was valid until 7 November 2009 subject to periodical audit and inspection. On the certificate (see Appendix 2), the vessel was described as fit-for-purpose as a fishing ship that was allowed to operate in:

> Coastal limits of New Zealand.
>
> Trawling only within 12 miles of the coast of New Zealand.

The SSM certificate (see Appendix 2) specified that no passengers may be carried and that lifesaving appliances were provided for a total of 3 persons.

1.5.17 Maritime Rules Part 91 (Navigation Safety Rules) (Part 91) replaced the Water Recreation Regulations 1974 and contained the basic navigation safety rules that had been in those regulations. Some modifications and additions were made to Part 91 to bring it up to date with modern boating technology and safety expectations. One of the new clauses required that a person in charge of a pleasure craft was responsible for providing sufficient lifejackets of suitable size for each person on board. This mirrored the requirements for lifejacket carriage on commercial vessels as prescribed in the maritime rules.

1.5.18 The Maritime Transport Act 1994 defines commercial and pleasure craft as (in part):

> Commercial ship means a ship that is not—
>
> (a) A pleasure craft

and

> Pleasure craft means a ship that is used exclusively for the owner's pleasure or as the owner's residence, and is not offered or used for hire or reward; but does not include—
>
> (b) A ship that is used on any voyage for pleasure if it is normally used or intended to be normally used as a fishing ship or for the carriage of passengers or cargo for hire or reward.

These definitions were also contained in Part 91.

1.5.19 Historically, owners of commercial vessels have often used them for pleasure purposes. Other than the definitions above, there was nothing specific in the maritime rules to allow or forbid this action. In 2005, the Safe Ship Management Code of Practice attempted to formalise the custom by requiring that, where vessels were to be used for the owner's pleasure, an entry be made in the logbook of the vessel and the SSM company advised. SSM companies could require on a case-by-case basis that such advice be given in writing. Inquiries of SSM companies indicated that some owners wrote the details of the intended departure from the rules in their logbook, but hardly any operators advised their SSM company of the intention to operate as a pleasure vessel. The *Kotuku* logbook was not recovered, but the owner indicated that he did not note in his logbook that he was operating as a pleasure vessel; neither did he advise his SSM company.

1.5.20 The Fisheries Act 1996 had strict rules concerning fishing permits (including the use of commercial fishing vessels for recreational fishing), and substantial penalties (including heavy fines and forfeiture of a vessel or associated property) were levied for non-compliance. Operators were required to keep good records of catch efforts. The *Kotuku* on 2 occasions had applied for and received a permit to undertake recreational fishing.

Stability and construction

1.5.21 Part 40D came into force on 1 February 2000. Part 40D applied to almost every New Zealand ship that was required to be registered under section 57 of the Fisheries Act 1983, or section 103 of the Fisheries Act 1996, or recognised by the Director as being engaged in fisheries research;

the *Kotuku* was such a vessel. Part 40D prescribed the standards of design and construction of fishing ships, and the equipment they were required to carry. Sections 34 and 35 required fishing vessels of less than 24 m in length and engaged in trawling, dredging or similar forms of fishing where heavy gear was towed, or engaged in purse seining, to undergo stability tests and freeboard assignation that had not been required for such ships previously. Intact stability for a vessel was required for 5 typical loading conditions.

The intact stability for a vessel was considered satisfactory if the following were met in each of the loading conditions:

(i) the area under the righting lever curve (GZ curve) must not be less than 0.055 metre-radians up to 30° angle of heel and not less than 0.090 metre-radians up to 40°. Additionally, the area under the righting lever curve (GZ curve) between the angles of heel of 30° and 40° or between 30° and θ, if this angle is less than 40° must not be less than 0.03 metre-radians. θ is the angle of heel at which openings in the hull, superstructure or deckhouses that cannot rapidly be closed weathertight begin to immerse; and

(ii) the righting lever (GZ) must be at least 200 millimetres at an angle of heel equal to or greater than 30°; and

(iii) the maximum righting lever (GZmax) must occur at an angle of heel preferably exceeding 30° but not less than 25°; and

(iv) the initial metacentric height (GM) must not be less than 350 millimetres for single deck ships; and

(v) the range of positive stability must not be less than 60°. The effects of enclosed deck erections with openings closed by approved weathertight fittings may be taken into account in determining the range of positive stability.

1.5.22 In recognition of the difficulties involved in undertaking stability tests on existing vessels, the rule allowed that such ships did not have to comply with the stability requirements until 1 February 2002, 2 years after Part 40D came into force.

1.5.23 Many older vessels, similar to the *Kotuku*, did not have as-built plans or line drawings, so it was necessary for the lines of a vessel to be measured and a plan of its hull prepared before a full stability assessment could be completed. This was usually done by a naval architect or shipwright and required the vessel to be out of the water. By 1 February 2002, the due date for the stability tests to be completed, a large number of vessels had not been measured or inclined. The Director of Maritime NZ allowed vessel owners to apply for an exemption from the stability assessment requirements until a date that corresponded with the next out-of-water survey of the vessel. On 20 June 2002, in a letter from the Director of Maritime NZ, exemptions were granted for 61 vessels, 37 between 12 m and 24 m in length, and 24 of less than 12 m in length. The latest compliance date for the *Kotuku* was 30 November 2005.

1.5.24 The advisory circular that accompanied Part 40D allowed that an alternative method on trawlers of less than 12 m in length could be used to determine the initial metacentric height of a vessel by carrying out an inclining test on the vessel in the departure for the fishing grounds condition and using the displacement of the vessel in the calculation. This alternative method circumvented the need for lines plans and so cost less than a full stability analysis. SSM companies applied to Maritime NZ to be allowed to conduct other methods of alternative stability tests on inshore trawlers of less than 16 m in length and a main engine of less than 200 kW (270 hp). On 26 September 2001, Maritime NZ accepted the alternative stability method proposed by SGS M&I. The *Kotuku* had an engine rating of 134 kW, was less than 16 m in length and was trawling in the inshore area, and so met the conditions for the alternative stability test. The SSM surveyor had taken some measurements of the hull of the *Kotuku* in November 2005, but at the time of the accident no stability test had been carried out.

1.5.25 In October 2007 Maritime NZ provided details of the status of the 61 vessels that had been issued exemptions in 2002. They were:

39 vessels had completed and passed the stability requirements

12 vessels had been archived, that was they were lost or removed from the SSM system

9 vessels had changed their occupation and no longer needed to comply with the stability requirements of Part 40D

1 vessel was laid up and had not completed a stability test.

1.5.26 In 2005 Maritime NZ commissioned an independent review of the fishing industry to determine the extent of compliance with Part 40D. The study was carried out confidentially and involved surveys of 58 vessels built before the year 2000: 29 vessels of 6 to 12 m in length and 29 vessels of 12 to 24 m in length. Maritime NZ received the completed review in July 2006. As part of the review Maritime NZ extrapolated the number of vessels that may be similarly non-compliant using a total fishing vessel population of 820; those figures are shown below in brackets after the percentage (note that not all 820 vessels were required to meet all the parts of Part 40D and so there was a disparity between the percentages and the number of affected vessels). Thirty parts of the rule were inspected against and the following parts were those that had high non-compliance:

- watertight bulkheads had a non-compliance rate of 69% (306 vessels)
- bulwarks and guardrails had a non-compliance rate of 65% (531 vessels)
- freeboard had a non-compliance rate of 62% (342 vessels)
- inlets and discharges had a non-compliance rate of 59% (491 vessels). The surveyor noted that outlets that were not fitted with non-return valves caused the greatest risk in this area
- hatchways had a non-compliance rate of 50% (404 vessels)
- bilge systems had a non-compliance rate of 43% (353 vessels) – assessed as a moderate threat due to cross-over and flooding possibilities
- water freeing had a non-compliance rate of 40% (325 vessels). The freeing port systems that were non-compliant either had locking arrangements or had sliding shutters.

Other significant non-compliance items were:

- stability had a non-compliance rate of 26% (155 vessels)
- lifesaving appliances had a non-compliance rate of 17% (139 vessels), but the surveyor noted that there was a high rate of lifesaving equipment being tied down or hindered from deployment by other equipment.

1.5.27 The survey results indicated that all fishing vessels of less than 24 m in length were non-compliant with at least one component of Part 40D.

1.5.28 In response to the review results Maritime NZ initiated a project to develop policies to improve compliance with Part 40D, including improvements in the consistency of surveys, inspections and audits carried out by the SSM companies. This project was progressing at the time of writing the report. An industry working group had drafted an amendment to Part 40D, which had been canvassed at SSM working groups. It was expected that the draft amendment would be available for public consultation by mid-2008.

1.6 *Kotuku* stability

1.6.1 In November 2005, the *Kotuku* was slipped for an out-of-the water survey. Following the completion of the survey, the surveyor issued a new SSM certificate and the vessel resumed operations. It was during this survey that the SSM company surveyor took a set of measurements of the vessel lines, but no further action was taken to carry out an inclining experiment or to complete a stability assessment.

1.6.2 After recovery, 2 naval architects, one on behalf of the Commission and one on behalf of Maritime NZ independently conducted 2 separate inclining tests and stability analyses on the *Kotuku*. The usual method used to determine the centre of gravity of a vessel was an inclining test, which was predominately conducted with the vessel afloat. However, the *Kotuku* was so badly damaged that it could not be refloated, so it was necessary to conduct the test on dry land using an alternative method. Completing the stability analysis required measuring the hull, from which a lines plan could be prepared and the shape of the hull could be modelled.

1.6.3 The naval architect employed by the Commission conducted the inclining test by lifting the vessel and placing it at an angle of heel on appropriately positioned load cells. The vessel was heavy, waterlogged and had little rigidity; consequently, it was difficult to place and balance on the load cells. Some of the internal strength members of the vessel had been damaged during the sinking and the recovery, which made it difficult to locate a point on the turn of the bilge that could bear part of the weight of the vessel; this was particularly so on the starboard side. In addition, one load cell failed during the starboard side inclination, but this measurement was able to be deduced by calculation. The hull and skeleton of the vessel were waterlogged and had little rigidity, which allowed the hull to twist and become distorted. There were no original plans or drawings for the vessel so it was necessary for the hull shape to be measured and drawn, the degree of distortion in the hull making this a difficult task.

1.6.4 The naval architect employed by Maritime NZ constructed a framework and cradle that was balanced on 4 load cells, and the vessel was placed onto this framework. Measurements were taken with the vessel upright and heeled. The cradles helped to minimise the difficulty experienced because of the softness of the hull and structure, but did restrict the angle of heel to which the vessel was inclined. The hull shape was measured after the inclining test.

1.6.5 The resulting stability data for the *Kotuku* from each of the naval architects was markedly different. The naval architect working on behalf of the Commission deduced that the vessel had marginal stability, and in its condition at the time of the capsize would have failed all but one of the stability criteria prescribed in Part 40D (see paragraph 1.5.21). Conversely, the naval architect employed by Maritime NZ found that the vessel would have met all the stability criteria prescribed in Part 40D.

1.6.6 In an attempt to resolve the differences in the stability calculations, the Commission engaged a third naval architect to critique the methodology and results of the Commission and Maritime NZ naval architects. The comparison was conducted in 2 parts: the first part was to compare the inclining and determination of the centre of gravity of the vessel, and the second part was to compare the hull shapes and hydrostatic data. In his report at the completion of part one (see Appendix 10) the third naval architect concluded that both inclining tests were inconclusive, because:

- the measurements taken by the naval architect on behalf of the Commission were not or could not be repeated to confirm their accuracy; and
- the test conducted on behalf of Maritime NZ restricted the heel of the vessel to 5° to port, an angle that resulted in low angle of intersection between the lines of action, and therefore the results were sensitive to small variations in load cell measurements.

He stated that the vessel was badly damaged and so it was not possible to heel it as far as would be wished, particularly to starboard. He went on to determine that the difference between each of the stability analyses could be explained, but could not be resolved.

In light of being unable to resolve the difference in the inclining data, the Commission discontinued the second part of the comparison.

1.7 Analysis of legislation, survey and stability

1.7.1 In 1997, with the advent of the SSM system, the philosophy behind shipboard safety changed, moving away from the existing annual survey system and moving towards a risk management based system that promoted owner and operator responsibility. Companies with larger fleets were able to dedicate sufficient resources to establish an effective SSM system, but smaller operators, particularly single-vessel owner operators, appeared not to understand the intent of the system and consequently grappled with its implementation. The principle of self-auditing, hazard identification, risk assessment and maintenance systems was difficult to grasp and even more difficult to implement. Since the SSM system had been in effect, people from all sections of the industry, including Maritime NZ, the SSM companies and the vessel owners and operators had struggled with its application at some time. Two reviews and an audit into the SSM system highlighted areas of concern that needed to be addressed. Maritime NZ introduced the Safe Ship Management Code of Practice in 2005, which dealt with many of the recommendations. However, in so doing it created confusion over the relationship between the maritime rules, the New Zealand Safe Ship Management Code and the later Safe Ship Management Code of Practice.

1.7.2 The maritime rules, which were intended to give speedy reactive legislation, have proved to be cumbersome, with extensive delays in their implementation and amendment. Such legislation has been slow to react to developments, both technical and operational, and domestic and international, resulting in an environment where dated rules struggle to meet the expectations of the industry, and where ambiguities lead to the inconsistent application of the rules.

1.7.3 The concept of a code of practice was to build on what was contained in the rules. However in this case, because of the difficulties and delays inherent in the rule-making process, Maritime NZ had attempted to fix the deficiencies in Part 21 with the publication of the New Zealand Safe Ship Management Code of Practice rather than expedite a change to the rule itself.

1.7.4 The *Kotuku* had been in the survey system since 1967 and had entered the SSM system when it started in 1997. During that time, there was no evidence in the survey reports that any of the surveyors had required hull fastenings to be pulled or the condition of the hull and sub-structure tested other than by visual inspection. The maritime rules, and all the consolidated design and construction requirements that had been in effect since the *Kotuku* had been built, had expressly prohibited the fitting of sliding freeing port covers, yet none of the surveys had identified or required this contravention to be corrected.

1.7.5 Designed to complement the SSM inspection and audit system, the risk-profiling SPAN system had been introduced to classify the safety profile of each vessel in the system. However, the versions up to and including that in place at the time of the accident had suffered problems. The SPAN issued for the *Kotuku* on 1 July 2005 was incomplete and therefore incorrect, and the average word picture had resulted in a better than average safety profile. When Maritime NZ discovered that a series of exceptionally low SPAN results had occurred, it produced a new form that allowed for the results of the word picture to be immediately available to the surveyor and the vessel owner. In the case of the *Kotuku*, the SPAN assessment that the SGS M&I surveyor made in November 2005 used the revised word picture. However, the surveyor took no further action other than to send the word picture to Maritime NZ, and at the time of the accident a new SPAN had not yet been formally issued to the owner. The difference in view between the surveyor and Maritime NZ with regards to what constituted a higher risk SPAN score evidenced a lack of clarity on the relevance of these scores. In a more established and trusted system, a higher word picture score could have been recognised by the surveyor to identify a vessel at an elevated level of risk. But, given the history of the SPAN system and the way the word pictures had been used previously it was unlikely that a surveyor would act upon the word picture alone. Data processing problems aside, the SPAN system through human bias and individual interpretation was still open to inconsistent results. At the time of the preparation of this report another version of the SPAN system was being developed where the result was based solely on the word picture total.

1.7.6 The application of a set of rules by various individuals inevitably leads to inconsistency, but reliability can be improved by stringent control. Maritime NZ, having devolved the survey function to private companies, had largely lost effective direct quality control over the surveyors and so there was a loss of standardisation throughout the survey system. The withdrawal of the MSIs from the inspection process removed another layer of control over the surveyors. SSM surveyor training seminars were held annually, during which Maritime NZ outlined its expectations and gave guidance on how the system should be administered. These seminars went some way to regaining control over the surveyors and the standards required of the industry, but as evidenced by the Part 40D review, the general standard of the less than 24 m in length fishing fleet in New Zealand fell well short of complying with the standard required by the rules.

1.7.7 SSM companies were in a commercially competitive market, which was not conducive to achieving a consistent and impartial level of inspection throughout the country. To accomplish a consistent standard of inspections there needed to be an appropriate level of monitoring by the regulator. Maritime NZ had begun to increase the monitoring of SSM companies about one month before the accident.

1.7.8 As a commercial fishing vessel, the SSM certificate of the *Kotuku* excluded the carriage of passengers, but had it been operating as a pleasure vessel there were no restrictions on the number of people that could be on board, other than the need for everyone to be provided with a lifejacket. By definition, a pleasure vessel specifically excluded a vessel that was normally used for fishing. Historically, however, fishing vessels have at times been used for their owner's pleasure. The recent Safe Ship Management Code of Practice had sought to address this issue and formalise the procedure to allow this departure from the rules, but it had had limited take-up from the industry. The discrepancy between the definition under the Act and the application of the Safe Ship Management Code of Practice was an example of inconsistencies within the legislation that caused confusion in operators and administrators alike.

1.7.9 From a safety point of view it was reasonable that owners should be allowed to use their vessels for pleasure; however, the absence of any formal process meant an opportunity was lost to ensure that the regulatory requirements for the relevant mode of use were met and that the 2 sets of requirements were not confused or misused. This was an example of where the maritime rules should have been more specific.

1.7.10 In direct contrast to the maritime legislation, the requirements under the Fisheries Act 1996 for commercial fishing vessels to be used for recreational fishing were onerous and required full records to be kept. There seemed to be a higher level of compliance with the fisheries legislation, probably because of the severity of the penalties that could be imposed for non-compliance, and the resources fisheries used to monitor compliance. This is a clear example of how industry respects and complies with clear law. The lesson which can be taken from this is that a regulator that takes too much of a "hands-off" approach, risks fostering an environment of non-compliance within an industry.

Stability

1.7.11 The weight of the cargo and additional people was not excessively heavy, and was probably less than that carried on the outward run to the island in April. The crew recounted large catches of fish that had been landed on deck during previous voyages; however, there was no data to indicate what the condition of the vessel was on those occasions. The quantity carried on the accident voyage would not, under normal conditions, be expected to compromise a vessel such as the *Kotuku*; even with the load on the deck rather than in the fish hold. However, had the cargo been securely stowed below, the stability of the vessel would have been improved.

1.7.12 Vessels that had not complied with the stability requirements of Part 40D by 1 February 2002 were given an exemption that extended the compliance date by almost a further 3 years, without any conditions being imposed on the operation of the vessels. Such exemptions and the continuing non-compliance with the maritime rules did not assist the safety profile of the industry and could be construed as giving tacit approval to widespread non-compliance.

1.7.13 The stability requirements in Part 40D were set for good reason. They were intended to identify at-risk vessels, allowing owners to take measures to improve their stability and thus prevent them from capsizing or foundering due to inadequate stability.

1.7.14 The extensions granted to the 61 vessels to complete the stability requirements were generous, but only 39 had completed the stability at the time of writing, and of those only 6 complied before their due completion date. This in itself was an indication that the fishing industry viewed maritime legislation with a certain degree of scepticism, which was not surprising given Maritime NZ’s and the SSM companies’ apparent tacit acceptance of non-compliance. Possibly, owners held the erroneous belief that older vessels had been operating for many years without incident and therefore should not be subjected to what might be perceived as a bureaucratic exercise. This occurrence, and other accidents involving older fishing vessels, was testament to the fact that such vessels were equally vulnerable or more vulnerable than their more modern counterparts.

1.7.15 The alternative stability test used by SGS M&I did not require the vessel to be taken out of the water, and as such could have been completed at any time during the almost 5 years between the Maritime NZ accepting the alternative stability test and the accident in 2006.

1.7.16 Where vessels did not meet the minimum stability requirements, owners had a number of choices. They could modify the vessels to meet the stability requirements, or they could cease trawling, dredging or similar forms of fishing where heavy gear was towed but continue other forms of fishing such as long lining, or they could decommission the vessel. Part of the resistance to make vessels available for stability tests may have come from the fear that a vessel would fail and so deprive owners of their livelihood. The costs involved in improving the stability of a vessel could well be prohibitive for an owner, and could result in the vessel being withdrawn from the industry, but that would be a better outcome than the possible loss of the vessel and the potential loss of life.

1.7.17 The stability tests carried out on *Kotuku* after its recovery proved to be inconclusive and could not determine the precise statical stability of the vessel at the time of its capsize. Over the vessel’s lifetime, the creep of weight upward and towards the stern as a result of the modifications would have eroded the vessel’s stability and reduced its freeboard aft.

1.7.18 The Commission explored many possible factors that may have led to the loss of the *Kotuku*, and has concluded that the most likely proximate cause was having entrapped water on deck at the same time as the vessel was rolled by an unexpectedly steep and high wave. Factors that could have contributed to the destabilisation included heel due to helm, water in the hull and shifting cargo during the roll.

1.7.19 The majority of the cargo was well aft; that, together with the full fuel tanks in the steering gear compartment, resulted in the vessel being trimmed heavily by the stern. The freeboard at the transom was estimated to be less than 500 mm; consequently, the heel necessary for the deck edge near the stern to become immersed was small. Once the deck edge had become submerged the residual stability of the vessel would have continued to diminish and the chance of the vessel recovering would have been small.

1.7.20 Descriptions of the final moments indicated that the first rolls to starboard and port were heavy and violent, whereas the final roll to starboard was comparatively slow and continuous. This would indicate that the condition of the vessel changed during those 3 rolls, suggesting that a rapid destabilisation took place, which supports the conclusion that a wave depositing a large volume of water onto the afterdeck was the proximate cause of the capsize. The comment by the deckhand referring to fish cases floating supports this scenario. Having water entrapped on deck can adversely affect the stability of a vessel in 3 ways:

- the weight of water on deck would cause a rise in the centre of gravity of the vessel and therefore a direct loss of stability
- the entrapped water would cause a free surface effect as it moves across the vessel causing a virtual loss of stability
- the freeboard of the vessel would be reduced by the additional weight of the water, which would result in the deck edge becoming submerged at smaller angles of heel and thus reduce the ability of the vessel to return to the upright.

1.7.21 Not completing the stability requirements of Part 40D denied the one definitive measurement of the stability of the vessel that would have indicated whether it was suitable to continue trawling and whether special care was needed when unusual weights were lifted or being carried. Had the vessel completed and failed the stability test, it could have been allowed to continue fishing using methods that did not require the towing of heavy equipment. Alternatively it could have continued operating as a pleasure vessel. In either of these cases, it is possible that it would still have been used to transport the muttonbirders and their cargo. However, had the stability of the *Kotuku* been known, those on board could have taken additional precautions, like putting the cargo in the hold and ensuring that the freeing ports were open and clear.

1.7.22 Had the vessel taken and failed the stability test, and consequently changed its mode of operation, it is probable that the superfluous heavy equipment used for hauling the trawl net could have been removed, with a resulting improvement in the overall stability of the vessel.

1.7.23 The result of the Part 40D review carried out on behalf of Maritime NZ, confirmed that there was widespread non-compliance in fishing vessels of less than 24 m in length. This supported previous accident investigation reports and anecdotal evidence that indicated many vessels were operating in a substandard condition. Such widespread non-compliance would indicate that surveys either were not identifying defects and putting corrective actions in place, or were identifying defects but, as in the case of compliance with stability requirements, simply were not concerned for the reasons given in the preceding paragraphs.

1.7.24 The individual parts of the rule identified in the Part 40 D review that were also non-compliance issues on the *Kotuku* during the period when the accident occurred were:

- watertight bulkheads: the only watertight bulkhead was the collision bulkhead, which because it was retrofitted was unlikely to have been effectively watertight
- bulwarks and guardrails: were lower than those specified
- inlets and discharges: the fire and bilge systems were common, with no non-return valves fitted on the bilge lines to the engine room or fish hold, so cross flooding could occur
- hatchways: the fish hatch was unable to be secured in position

- bilge system: there was no non-return valve on the 24-volt bilge pump
- water freeing: unsuitable freeing port covers
- stability: not completed
- freeboard: not completed
- lifesaving appliances: improperly fitted.

Additionally, as *Kotuku* could possibly have been considered to be operating as a pleasure craft at the time of the accident, Part 91 was not complied with, as there were insufficient lifejackets on board for the number of persons carried.

1.8 Search and rescue

1.8.1 The *Kotuku* capsized continuously but slowly to starboard. Once the vessel had capsized, it remained steady in its inverted state. The survivors who managed to get onto the upturned hull had no difficulty staying there, the keel even providing a little shelter from the wind. Eventually, the bow started to settle in the water and the survivors on the hull decided that they should swim for the shore before the vessel sank. After they reached Womens Island, the former skipper and his nephew could still see the hull of the *Kotuku*, but a short time later when they looked it had disappeared from sight.

1.8.2 The fadge that the owner and his friend used for flotation, and a couple of fuel oil containers, were the only debris that came to the surface at the time of capsize. The bulwarks and pond boards appeared to have prevented other buoyant debris floating clear until the vessel eventually sank.

1.8.3 The members of the family were in mobile phone communication with people in Bluff during the trip and those people were aware of the expected arrival time of the *Kotuku* at Bluff. No distinct trip report was made to maritime radio; however, both the Bluff and Stewart Island Fisherman's Radio station operators were aware that the vessel was in the area.

1.8.4 In the phone calls between the muttonbirders and those who would meet them at Bluff a rough estimated time of arrival at Bluff of 1600 was mentioned, but it was also suggested that if they considered the weather to be too rough, the vessel would divert to Half Moon Bay for the sister and younger persons to catch the ferry back to Bluff.

1.8.5 When the vessel had not arrived in Bluff by about 1615 the wife of the father phoned the Stewart Island Fisherman's Radio operator asking her to check the harbour to see if the *Kotuku* had diverted there. The radio station was remote from the harbour, so the operator phoned the local ferry office for them to check if the vessel was in the harbour. At about the same time the operator called the *Kotuku* on VHF channel 65. There was no response.

1.8.6 Several further phone calls took place over the next 30 minutes or so between the radio operator and Stewart Island fishermen to see who had last seen the vessel. During these conversations the owner and skipper of the fishing vessel *Wildfire* was asked to ready his vessel for a search. At about 1720, the wife of the father again called the radio operator, who then contacted the local police constable and the local fishermen to initiate a search.

1.8.7 At about 1735, the ferry *Foveaux Express* was on passage from Bluff to Stewart Island just northwest of North Island, when the master sighted debris in the water. The debris consisted of many 10-litre plastic buckets of the type used for muttonbirds, a fadge, pond boards and oil containers. He reported this find to the radio operator of Stewart Island Fisherman's Radio and then steamed to the northwest, along the debris trail, to check out what else was contained in it. The radio operator reported this to the local police constable.

1.8.8 Sunset was at 1720 and so it was starting to get dark at about the time the search was getting under way.

1.8.9 At about 1800, someone on the *Foveaux Express* noticed a flashing light on Womens Island. At about this time the *Wildfire* left Half Moon Bay on its way to the Muttonbird Islands. The Foveaux Express closed with the flashing light on the shore, but was unable to get close enough to hear what the survivors were calling out. When he arrived on the scene, the skipper of the *Wildfire* was able to get close enough to talk with those on the shore and get details of what had happened and the number of people involved. He relayed this information to the police through the radio operator.

1.8.10 From 1800 onwards the search gathered momentum, with vessels from Bluff, Half Moon Bay and Riverton, and helicopters from Te Anau and Dunedin, taking part.

1.8.11 During the evening, a helicopter recovered the 3 survivors from Womens Island. The search continued during the night, but only the body of the friend of the owner was recovered during that time.

1.8.12 The following morning the body of the deckhand was recovered from the northern side of Womens Island. At about 1230 that day the wreck of the *Kotuku* was found at a depth of a little over 30 m in position 46° 48.570'S 168° 14.627'E. A grapnel with fishing floats attached was used to mark the position of the wreck. Soon after, the body of the sister surfaced close to the wreck and was recovered.

1.8.13 On 15 May 2006, members of the police dive squad inspected the wreck and were able to recover the 3 remaining bodies.

1.9 Medical

1.9.1 The former skipper (aged 46) and his nephew (aged 16), reached the shore on the eastern side of the island from where they were able to climb a track to the centre of the island to a muttonbirder's house, in which they found dry clothing and food. They also found torches, which they later used to attract attention. The owner (aged 56) reached the foreshore on the western side of the island, but due to exhaustion and hypothermia was unable to move clear of the beach, seeking shelter in a shallow cave instead. He became further hypothermic before being rescued. None of these men were significantly injured, the owner being the only one needing hospitalisation for hypothermia.

1.9.2 The body of the deckhand (aged 34) was discovered high on the foreshore where he had apparently crawled after he left the water. The post-mortem examination revealed there were no significant physical injuries present, but there was pulmonary congestion and oedema. The reported cause of his death was hypothermia. Routine toxicology reports obtained as part of the post-mortem examination showed a blood alcohol level of 39 milligrams per 100 millilitres,[3] a urine alcohol level of 122 milligrams per 100 millilitres and a TetraHydroCannabinol (THC) blood level of 2 micrograms per litre.

1.9.3 The body of the owner's friend (aged 52) was located in the sea close to Womens Island. He had initially used a fadge for flotation but was found separated from it. The reported cause of death was cold water immersion. The post-mortem examination revealed there were no significant physical injuries present, but there was pulmonary congestion and oedema. Routine toxicology reports obtained as part of the post-mortem examination revealed samples to have a blood alcohol level of 85 milligrams per 100 millilitres[3] and a urine alcohol level of 134 milligrams per 100 millilitres.

1.9.4 The body of the sister (aged 41) floated free of the hull the day after the capsize. Post-mortem findings indicated that she was uninjured and that the cause of death was drowning. Routine toxicology reports obtained as part of the post-mortem examination revealed samples to have a

[3] For comparative purposes the legal blood alcohol limit for driving on the road was 80 milligrams per 100 millilitres.

blood alcohol level of 125 milligrams per 100 millilitres[4] and a urine alcohol level of 170 milligrams per 100 millilitres.

1.9.5 The bodies of the father (aged 78) and the two 9-year-old boys were located within the hull of the *Kotuku,* 2 days after the capsize. Post-mortem findings indicated that they had all drowned. None were seriously injured, although the father, who was at the helm at the time of the accident, had lacerations to his scalp. Routine toxicology of the father revealed no evidence of drugs or alcohol.

1.9.6 Factors that can affect survival time include sea state, seawater temperature, air temperature, wind chill, age, gender, anaerobic fitness, swimming ability and associated physical injury. One of the most important factors that helps survival in cold sea water is flotation assistance. A self-righting lifejacket that keeps the wearer's head clear of the water as well as providing buoyancy when impaired by physical fatigue or hypothermia is preferred. With a seawater temperature of 12ºC and moderate seas, an adult male wearing an appropriate lifejacket could be expected to have a fair chance of survival for up to 5 hours. Without flotation assistance, swim failure caused by a combination of muscle fatigue, cramps and hypothermia can be expected after about 20-30 minutes.

1.10 Lifesaving appliances

1.10.1 The most recent survey recorded that the *Kotuku* was provided with sufficient lifesaving appliances for the 3 crew it was certified to carry. The owner said that an additional 2 lifejackets were carried to supplement the standard complement. One older International Convention for the Safety of Life at Sea (SOLAS) kapok-filled lifejacket was the only one recovered from the wreck, and that was waterlogged.

1.10.2 In November 2004, the owner had bought an RFD Pacific-4 liferaft from RFD in Christchurch, when his previous RFD Surviva-6 RF liferaft was condemned during a survey. At the same time he bought a new Hammar H2O hydrostatic release unit (HRU) (see Figure 10) as was required for a fishing vessel that was licensed to operate in the coastal area. The new liferaft and HRU were transported to Bluff for the owner to install. The liferaft supplier said that it had representatives in Auckland, Wellington, Christchurch and Nelson. New liferafts delivered in those areas were installed by them, but this was not usually the case in other ports such as Bluff, where installation by the manufacturer incurred an additional charge and so purchasers usually installed the liferafts themselves. The owner requested that the supplier pack a 121.5 MHz EPIRB into the liferaft as an additional safety measure. The Pacific-4 liferaft was manufactured for RFD by the French company Plastimo and had been type approved by Maritime NZ in 1991. The liferaft of the *Kotuku* had been serviced by RFD Christchurch, as required, in November 2005.

1.10.3 Post-accident buoyancy tests showed that the packed liferaft maintained positive buoyancy, such that it would float towards the surface if unrestrained (see Appendix 6), to a depth of at least 35 m. However, its positive buoyancy decreased as the depth increased to the point where a diver at a depth of 35 m could hold it against the buoyancy up-thrust.

1.10.4 After completion of the buoyancy tests, the liferaft was activated to demonstrate that it would have operated if it had deployed. Once the painter was fully extended a short sharp tug triggered the gas bottle and the liferaft inflated correctly. On inspection, some of the items inside the gear bag were dented, suggesting that the inner bag had been subjected to high pressure when the liferaft was submerged.

1.10.5 The Hammar H2O HRU was designed and certified to operate at a depth of between 1.5 m and 4 m. It was a non-serviceable item that was required to be replaced every 2 years. This type of HRU had been in production since 1986 and was certified and approved by many classification

---

[4] For comparative purposes the legal blood alcohol limit for driving on the road was 80 milligrams per 100 millilitres.

societies and maritime administrations around the world. Maritime NZ issued a certificate of acceptance of the HRU on 5 March 2002. The Hammar H2O HRU was used extensively throughout the world.

1.10.6 The HRU was operated by a pressure device that activated a spring-operated blade, which severed a loop of line through which the liferaft securing lanyards were secured. The installation instructions that accompanied each HRU explained that a slip hook or similar should be used to allow easy manual deployment of the liferaft. The HRU was fitted with a weak link, which was designed to release at 2.2 + or – 0.4 kilonewtons, to which the liferaft painter was intended to be secured. On the *Kotuku* there was no manual quick release provision in the liferaft securing system.

1.10.7 The operating part of the *Kotuku* HRU was never recovered, having activated at some point during the capsize and sinking: however, the lower securing part and the weak link were still attached to the inboard securing rope. The HRU manufacturer was able to provide quality control test results for the batch of 500 units from which the *Kotuku* HRU came. Twenty HRUs, chosen at random from each batch, were tested in a pressure chamber and their activation depth recorded. The 20 HRUs from the *Kotuku* batch that were tested activated between 2.2 m and 2.8 m. In addition to these pre-distribution tests, the manufacturer said that it routinely tested units returned after they had passed their expiry date, without any failures.

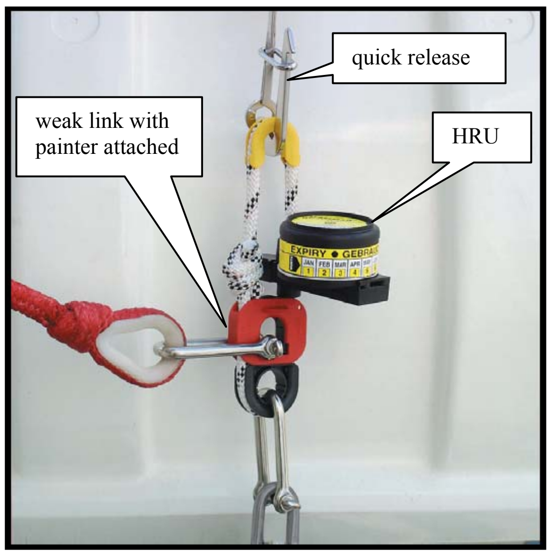


Figure 10
Hammar H2O hydrostatic release unit

1.10.8 When the liferaft was sent to the owner no installation instructions accompanied it. However, there was a notice on the liferaft casing that stated:

Attach operating line to strong point on ship

In the case of the *Kotuku* the liferaft painter was secured through a hole in the liferaft cradle, rather than to the weak link on the HRU.

The liferaft manufacturer later stated that comprehensive installation instructions were usually sent with a new liferaft. In addition, the HRU manufacturer said that every new unit had a self-adhesive liferaft label attached to it showing how the unit should be installed.

1.10.9 The liferaft manufacturer was asked what effect securing the painter to the ship rather than to the HRU weak link would have. It replied:

> If the painter was secured to the boat, and not the weak link, the liferaft would not be able to float free of the sinking boat. There is a specific weak link built into the hydrostatic release which the painter line must be tied off to. The approximate buoyancy of the inflated liferaft is 460 daN [dekanewtons, i.e. 10 Newtons]. The load required to break the painter line is 500kg. The new ISO 9650 standard will require the breaking strength to increase to 750kg. The use of a hydrostatic release in all liferaft installations should be mandated in our opinion.

1.10.10 The liferaft cradle on the *Kotuku* had been built for the previous liferaft, the RFD Surviva-6 RF (see Figure 11). The cradle had consisted of 2 shaped bearers onto which a rectangular wooden frame was mounted into which the liferaft was placed. To accommodate the new liferaft, the wooden framework was removed, leaving the 2 parallel bearers, the indent of which was just large enough to fit the new liferaft. To stop chafing between the liferaft and the cradle, the owner had inserted 2 strips of carpet, making the fit of the liferaft snug.

1.10.11 When the *Kotuku* was recovered it was noticed that the liferaft was wedged into the cradle (see Figure 12), so tests were carried out to determine what force was required to free it (see Appendix 6). There was a slight difference in the test results between when the carpet strips between the cradle and the liferaft were wet or when they were dry. An overall force of about 60 kg was needed to lift the liferaft from the cradle. The dry weight of the case and liferaft was about 40 kg, so a holding force of 20 kg was being exerted on the liferaft. The vertical shoulders on the cradle indent prevented any sideways movement of the liferaft. The painter grommet was aligned with one of the cradle indents, further tightening the fit.

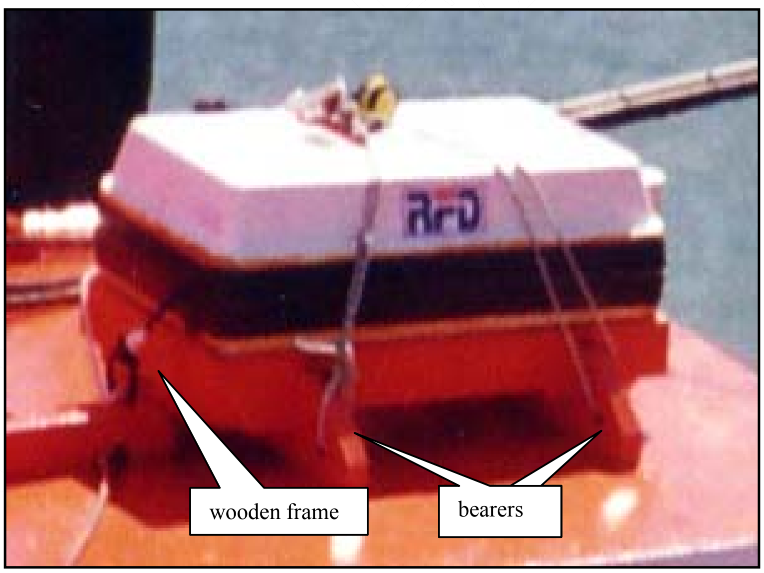


Figure 11
Surviva-6 RF liferaft in its cradle

1.10.12 Specially designed cradles (see Figure 13) were available for the stowage of the Pacific-4 liferaft, at an additional cost of about $120. These cradles had raised cruciform sections that were designed to interlock with corresponding cruciform indents in the liferaft case. The cradles provided a secure base on which to store the liferaft that did not pinch or exert any holding force on it. In addition, the shoulders of the cradles were curved and low enough to allow the liferaft to disengage should the liferaft deploy with the cradle at a large angle.

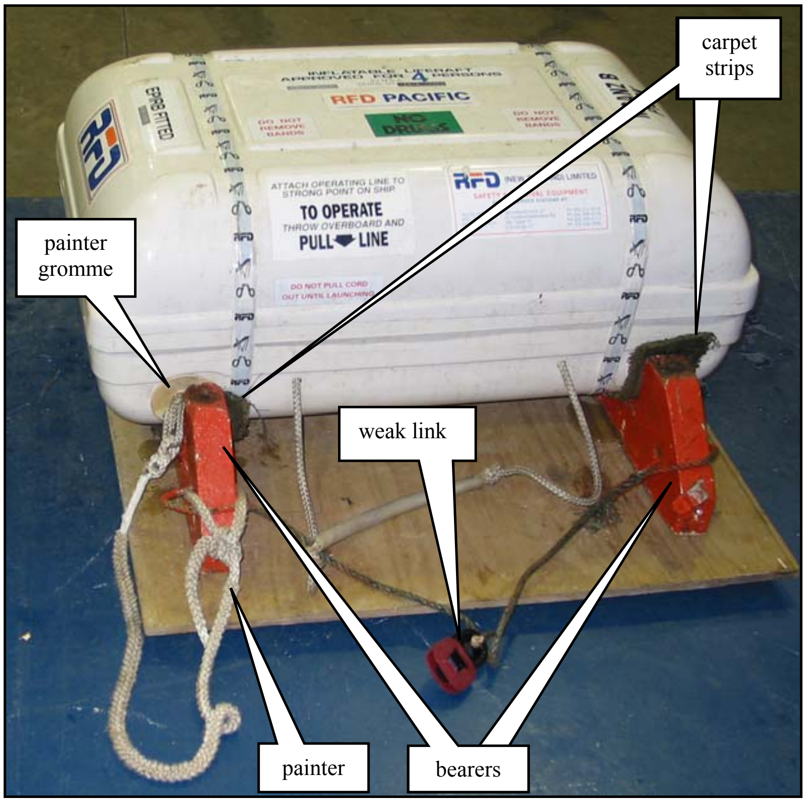


Figure 12
Pacific-4 liferaft on the reconstructed cradle

Figure 13
Specially designed cradle for the Pacific-4 liferaft

1.10.13 In addition to the liferaft there were 2 lifebuoys, which were stowed in cradles in front of the wheelhouse. The one on the port side floated free at some time during the capsize and sinking and was recovered by a searching vessel; it had a self-igniting light attached that was still working when recovered. The lifebuoy on the starboard side remained fast in its cradle throughout the sinking and recovery of the vessel; it had a line attached.

1.11 Analysis of capsize and survivability

1.11.1 The adult personnel on board at the time of the capsize were experienced and knew the conditions that could be encountered in Foveaux Strait. Even the non-seagoing people, including the children, were used to being on vessels similar to the *Kotuku*.

1.11.2 The owner was on board the *Kotuku* and so would traditionally be the person in charge. However, on this occasion he was happy to allow the qualified and experienced father of the former skipper to take control of the vessel for the voyage to Bluff. Regardless of whether *Kotuku* was operating as a commercial or pleasure vessel, given the father's qualifications and experience this was reasonable and legally acceptable.

1.11.3 The family determined that the weather was not sufficiently bad for the vessel to divert to Half Moon Bay to drop off the sister and younger people. They also decided not to deploy the stabilising paravanes to ease the motion of the vessel. This would indicate that, although gale-force winds were forecast for that evening, the prevailing weather was not considered threatening for the short trip home.

1.11.4 The sea conditions described by the survivors ought to have been within the capability of a vessel of similar design and size to the *Kotuku*. The height of individual waves within a sequence varies considerably, so oceanographers use significant wave height as a benchmark, where waves of lower and higher than the significant wave height were expected. Experienced seafarers were used to the concept of the occasional wave being higher than the significant wave height. In addition, operators that work in areas where the sea bottom shelves, or near outcrops or isolated rocks, were aware of the possibility of overfalls and unusually turbulent seas in those areas.

1.11.5 There were reports that unusual seas could be experienced in the vicinity of the North Isles and a local fisherman described an incident that happened in the area in about 1992 where an isolated unexpectedly large wave struck his vessel and rolled it onto its beam end. The fisherman could not remember all the circumstances surrounding the incident but thought that it occurred in similar sea and tidal conditions to that prevailing at the time of the *Kotuku* capsize. That incident does indicate that unusual waves could be encountered in the seas around the North Isles.

1.11.6 The father had been brought up on Stewart Island and in the waters of Foveaux Strait, and knew the vagaries of the weather and tides that could be experienced. He chose to take the route inside Bench Island and through the Muttonbird Islands, probably to maximise the time they were afforded the shelter of Stewart Island, but also to make the best use of the currents. Taking such a route was common for people with a similar level of local knowledge and experience as the father. Conversely, someone with less local knowledge, such as the owner of the *Kotuku* or the skipper of the *Reliance,* would take the slightly more exposed but navigationally easier route outside the Muttonbird Islands.

1.11.7 The father had steered the *Kotuku* previously, but that was before the steering had been changed to a hydraulic system. He had steered other vessels with hydraulic steering and would have been aware of how little effort was needed to turn the wheel. However, in the heat of the sudden first roll to starboard, the father may have inadvertently applied more port helm than he intended.

1.11.8 The application of full port rudder at or just before the second wave struck the vessel would have induced a small initial heeling moment to port before a much larger heeling moment to starboard would have taken effect. On a vessel moving at about 5 knots the resulting heeling moments would be small, but it would have compounded any heeling moment induced by a wave.

1.11.9 At the time of the final roll to starboard, the deckhand was said to have called out that there was something wrong and also mentioned fish cases floating. Although none of the other survivors saw any water on deck, given the description of the way the vessel rolled, it is probable that there was water trapped on deck and that the fish cases and cargo would have shifted with the movement of that water.

1.11.10 The *Kotuku* almost certainly experienced a couple of higher than average waves in an area where the sea bottom was shelving. One description of the first roll was that the vessel felt like it had fallen into a hole or trough of a wave. Such a change in the formation of a wave often occurs where the depth of the water decreases, as it did in the area to the northwest of North Island.

1.11.11 Once upside down the vessel became stable, so almost none of the debris usually associated with a capsized vessel floated free. It was not until the vessel started to sink that the pails of muttonbirds, fuel containers and other flotsam floated free to form a debris trail.

1.11.12 The survivors that remained with the vessel noted that it started to settle by the bow, a situation that could be expected due to the differences between the water plane shape of the bow and the stern. The damage to the forepart would suggest that the vessel was nearly vertical when the bow impacted the seabed (see Figure 14). The only other damage to the superstructure was a slight crack in the wooden mast forward of the wheelhouse, which was possibly due to the vessel pivoting on it as it settled towards the seabed.

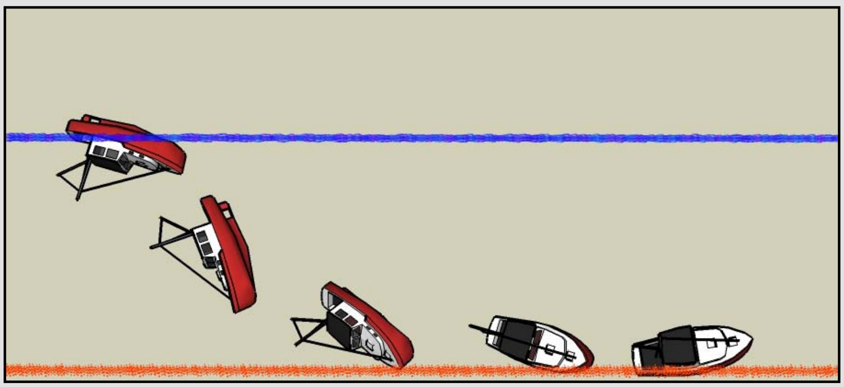


Figure 14
Probable sinking sequence

1.11.13 There was a time delay of about 2 hours between when the accident happened and when the vessel became overdue. When the vessel failed to arrive at Bluff by the expected time, further inquiries were made to check if it had diverted to Half Moon Bay before a full-scale search and rescue was launched. The *Foveaux Express* encountering the debris trail coincided with the increased awareness that the *Kotuku* had not diverted to Half Moon Bay that afternoon.

1.11.14 The sudden and unexpected capsize prevented the use of any of the safety equipment on board the vessel. Had someone managed to grab the flares or a waterproofed VHF radio or a mobile phone in a watertight bag or an EPIRB then the search and rescue effort may have been started sooner. The provision of a float free EPIRB may have alerted authorities earlier and allowed the search to be started before nightfall. By the time the search and rescue units were able to respond to the alarm, night had fallen making the search for people in the water or on wreckage extremely difficult and time-consuming. In addition, the forecasted deterioration in the weather occurred, which made conditions demanding for those involved in the search.

1.11.15 The use of a VHF radio in preference to phones to check the whereabouts of the *Kotuku* would have improved the chance of the search and rescue operation being started earlier. More operators in the area would have been aware that a situation was developing, making them better able to respond once the casualty was confirmed.

1.11.16 There was some initial confusion about the number of people on board the *Kotuku* when it capsized, and even after the first responders had managed to talk to the survivors on Womens Island the extent of the disaster was not known. Only after the police were able to talk to the survivors in person was the magnitude of the accident known.

1.11.17 The 2 men that made it to the house on Womens Island were fortunate to find a well-stocked muttonbirder's house from which they were able to get dry clothing, food and torches. Without these items they may well have remained undiscovered, wet and cold until the following day, possibly resulting in increased exposure and hypothermia.

1.11.18 Once the owner made it to the shore, he did not have sufficient reserves of energy to get himself off the beach. Had he not been located quickly he would almost certainly have succumbed to hypothermia during the night.

1.11.19 There were not sufficient lifejackets for everyone on board. The usefulness of lifejackets can be determined by a number of factors:

- their size in relation to the wearer
- their type
- their accessibility
- the nature of the emergency.

1.11.20 For those trapped in the wheelhouse when the vessel capsized, wearing a full lifejacket would have hindered their attempts to escape from the enclosed cabin space because they would have had to overcome the buoyancy of the lifejacket to pull themselves down and out through a means of egress.

1.11.21 There are types of inflatable lifejacket, some small enough to be worn constantly and others incorporated into heavy weather jackets, which would not have hindered escape; but sometimes this type of lifejacket does not provide as much support and self-righting capabilities as fully approved lifejackets.

1.11.22 The key to the best chance of survival is to have a number of lifejackets at least equal to, or preferably more than, the number of people on board, and stowed in the most readily accessible place. This would typically be near to, or if possible outside, the means of escape from the cabin.

1.11.23 The stowage of the lifejackets in the forward cabin was such that no person was able to grab one during or after the capsize. For those that were trapped and drowned in the cabin, a lifejacket would not have increased their chance of survival. Nevertheless, under different circumstances a lifejacket might have been crucial to their survival. The point is that having sufficient appropriate lifejackets on board and appropriately stowed will reduce the overall risk associated with accidents, and survival, at sea.

1.11.24 For those who had escaped from the hull, the availability of suitable lifejackets would have improved their probability of extended survival, even in rough sea conditions. A survivor wearing a lifejacket would have been better equipped and more free to make the decision to swim to shore from any ad hoc flotation aids such as the fadge. In addition, the reduced effort required to stay afloat would have increased their range of swimming towards a place of safety and minimised near-drowning submersions, which contribute, if prolonged, to the development of exhaustion and hypothermia. Those who reached land would have achieved their goal in better condition, and the probability of avoiding exhaustion hypothermia and swim failure would have been enhanced, if those free in the water were using lifejackets.

1.11.25 The post-mortem of the 2 men that escaped the upturned vessel but subsequently succumbed suggested that death was due to hypothermia and cold water immersion, probably accelerated by near-drowning experiences. Toxicology showed that both men had moderate blood alcohol levels. Because alcohol accelerates hypothermia through increased rates of heat loss due to increased blood flow through the skin, the alcohol in their blood systems reduced their chances of survival.

1.11.26 In the case of the friend of the owner, he probably lost grip of the fadge he was using as flotation through the effects of hypothermia and exhaustion. Having lost grip of the fadge, he did not have a lifejacket to support him in the water in a position that would best aid survival. His blood alcohol level and not having a lifejacket would have decreased his chances of survival and were factors contributing to his death.

1.11.27 In the case of the deckhand, he did succeed in reaching the shore, but through a combination of exhaustion and hypothermia was unable to make it to the shelter of the muttonbirder's house. Similarly, alcohol and not having a lifejacket decreased his chances of survival and were factors contributing to his death.

1.11.28 In the case of the sister, it could not be established to what degree she was impaired by the alcohol found in her blood system, but any impairment would have hindered her attempt to escape from the cabin of the upturned vessel.

1.11.29 In the case of the survivors, it could not be established what their level of impairment was, and consequently what level of risk they placed themselves in by consuming alcohol, because there is currently no legal means of compulsory post-maritime accident and incident testing.

1.11.30 Over its history the Commission has investigated a number of occurrences in the air, rail and maritime sectors where the effect of performance impairing substances was contributory to the occurrence. One such occurrence, involving the loss of the fishing *Iron Maiden* resulted in the following safety recommendations being made to the regulatory authority:

027/05 continue to consult with industry over the use of alcohol and drugs on ships with the objective of developing a comprehensive drug and alcohol policy to be included in all safe ship management manuals.

037/05 draft legislation for consideration by the Minister of Transport that will provide the necessary legislative framework to support the industry and individual operators in their implementation of a comprehensive drug and alcohol policy.

On 8 June 2005, the Director of Maritime Safety replied that:

027/05 This recommendation is not accepted in its current form.

As explained in our letter of 21 April to the Commission, the Maritime Safety Authority would accept a recommendation which required MSA to "continue to consult with industry over the use of alcohol and drugs on ships with the objective of developing a generic drug and alcohol policy, supported by appropriate legislative frame work for the transport sector".

037/05 This recommendation is not accepted.

It is the role of the Ministry of Transport, not the Director of MSA, to advance any proposal to Government for legislative change. This was clearly stated to the Commission by the Ministry in its letter of 9 May and for this reason the subject recommendation should be addressed to the Ministry of Transport.

1.11.31 In 2005, the Ministry of Transport convened the Substance Impairment Group. That group was in the process of developing a consultation document to establish how best to regulate the air, rail and maritime sectors in regard to substance impairing substances. It was scheduled that the consultation document would be released in mid 2008.

1.11.32 The liferaft and its equipment were in survey and had been serviced, as required, in November 2005. The inclusion of an additional EPIRB in the liferaft was positive and, had the liferaft deployed and had someone been able to board it, the EPIRB could have assisted searchers to locate the liferaft.

1.11.33 The failure of the liferaft to deploy was a factor in the deaths of the 2 men that escaped the upturned hull but later died, so tests were conducted to determine why it did not deploy. The initial suspicion was that the HRU failed to operate, but when the divers first inspected the wreck they found the liferaft in its cradle and the body of the HRU missing, which indicated that it had operated. The depth at which the HRU activated could not be determined, but the quality control system of the manufacturer was checked and found to be thorough, suggesting that the HRU was more likely to have operated within its design parameters.

1.11.34 When the vessel capsized, the depth of the wheelhouse roof and the liferaft would have been at about 2.5 m, towards the lower end of the HRU operating depth limits. However, even if the HRU had activated at that point the inherent positive buoyancy of the liferaft would have tried to make it float, which would have pushed it into the inverted cradle.

1.11.35 The determination that the HRU had operated within its specifications required other factors that caused the non-deployment of the liferaft to be considered. The cradle had been specifically made for the replaced Surviva-6 RF liferaft and then adapted for the Pacific-4 liferaft, when that liferaft was purchased in 2004. Carpet strips placed between the liferaft and the cradle bearers by the owner to prevent chafe also made the liferaft a snug fit in the cradle; tests established that there was about 20 kg holding force between the liferaft and the cradle. Given that the liferaft had 34 kg of positive buoyancy at the surface, and that it had to overcome 20 kg of resistance due to holding force, the liferaft would most probably have deployed if the vessel had sunk when upright.

1.11.36 The vertical shoulders on the liferaft cradle stopped the liferaft slipping sideways and, coupled with the positive buoyancy pushing the liferaft into the cradle, removed any possibility of it being washed clear of the upturned hull. Consequently, irrespective of whether or not the HRU had activated when the vessel first capsized, the liferaft was unable to clear the cradle. The liferaft may have assisted the 2 men that later died if it had deployed when the vessel capsized or soon after. But, if the liferaft had deployed when the *Kotuku* eventually sank, which it did not, it was questionable whether it would have reached the surface because the painter had not been attached to the weak link on the HRU that was designed to part and allow the liferaft to float free.

1.11.37 The design of a purpose-built cradle available from RFD was such that it would keep the liferaft secure while lashed down, but only exerted minimal sideways force, and allowed easier deployment of the liferaft once the lashing was released. It is uncertain whether the liferaft would have deployed during the capsize or while the vessel was floating upside down if the purpose-built cradle been used, but there would have been more chance of it doing so. There would have been a greater chance of the liferaft deploying during the sinking sequence; however, by that time there was no one left on the upturned hull to make use of it.

1.11.38 The evidence suggested that the vessel sank vertically by the bow in a depth of 32 m. If that was the case, being 14.2 m in length, it would not have gathered much momentum by the time it struck the sea bottom. Additionally, the buoyancy of the vessel would have slowly decreased as the entrapped air escaped and became compressed with depth, so although the rate at which it sank would have slowly increased the vessel would not have gathered much momentum over the 18 or so metres until the bow made contact with the bottom. The damage to the bow area confirmed that it was the point of impact, but it appears to have crumpled, much like the forward section of a modern car, and so reduced the force of the impact. Had the liferaft been loose in its cradle it would have been expected to have deployed during the sinking, when the vessel hit the bottom or when the vessel laid over on its starboard side, but this did not happen.

1.11.39 Tests indicated that the liferaft remained positively buoyant to at least the depth at which the *Kotuku* sank, but that the buoyancy did diminish with depth. The positive buoyancy at 35 m had decreased to such an extent that a diver was able to hold it down, but there was still sufficient buoyancy for the released liferaft to float to the surface from that depth.

1.11.40 There was no slip mechanism on the liferaft lashing, as recommended by the HRU manufacturer, and so it would have been more difficult to manually deploy the liferaft; however, most fishermen carry a knife with which they could have cut the lashing. The liferaft painter was made fast to the cradle rather than to the weak link on the HRU, contrary to the installation instructions from the HRU manufacturer. Although neither of these issues would have affected the outcome of this accident for the reasons given above, the lesson to be learnt is that lifesaving equipment will have a better chance of aiding survival if it is properly installed.

1.11.41 There were reportedly no installation instructions supplied with the liferaft, although attached to the HRU were instructions of how normally it should be used to secure the liferaft and how the painter should be attached to the weak link. There was no representative of the liferaft supplier in Bluff, or in many smaller ports in New Zealand. Due to the additional costs involved in employing the manufacturer to install a liferaft, it was unlikely that an owner would use that service, and so the possibility for incorrect installation remained. This necessitated more vigilant inspections of lifesaving appliances by surveyors in such ports. It also indicated the need for installation instructions to be provided with the equipment. Since the Pacific-4 liferaft had been installed there had been 2 surveys, neither of which detected the holding force exerted by the cradle, the absence of a slip in the lashing or the incorrectly secured painter.

2 Analytical overview

2.1 The *Kotuku* was an established vessel that had been built at a time when there were few regulations governing the design and construction of fishing vessels. The absence of any subdivision, particularly transverse watertight bulkheads, condemned any such vessel to progressive flooding should its watertight integrity be breached. Such flooding would inevitably lead to foundering. However, in this case, flooding was unlikely to have been the principal cause of the loss of the *Kotuku* but it could not be ruled out as a contributing factor. There was a large population of fishing vessels within the New Zealand fishing industry without watertight subdivision that were also susceptible to total flooding.

2.2 The hull fastenings showed the effects of long-term electrolysis, which indicated that the planking of the *Kotuku* had been saturated for many years before the capsize. Wasted fastenings increased the risk of springing one or more hull planks and breaching the watertight integrity of the vessel. The hull planking, particularly under the sheathing around the quarter of the vessel, showed signs of advanced decay. A butt joint between 2 hull planks on the starboard quarter exhibited signs of decay both in the plank ends and in the butt block behind the joint, which would have in all probability allowed water to leak into the hull.

2.3 Bilge alarms or automatic pumps with wheelhouse indicators were a sensible and economical early-warning protection against flooding, but were not required under the maritime rules for vessels without an enclosed engine room. Pro-active surveyors often recommended that owners fit such alarms because of their cost-effectiveness. The description of the vessel movement during the capsize suggested that destabilisation was sudden, more sudden than would be expected to be caused by flooding through an opening in the hull. However, if flooding had occurred, those on board may not have been aware, and it could have contributed to a loss of freeboard, and therefore the subsequent accumulation of water on deck and the reduced ability to right itself.

2.4 The weight of cargo on board at the time of the accident was estimated to be about a tonne, which should have been insufficient to destabilise the vessel. However, the majority of the cargo was stowed well aft and this, combined with the full fuel tanks in the steering gear compartment, would have caused the vessel to trim more by the stern. The low freeboard aft would have made the vessel susceptible to taking water on deck over the side bulwarks near the stern and would have resulted in early deck edge immersion, with a consequential reduction in the ability of the vessel to right itself.

2.5 The sliding freeing port covers on the *Kotuku* did not comply with the maritime rules. While closed they would have prevented the rapid dissipation of any water that landed on the deck. Consequently, a wave that broke over the bulwark would result in a large amount of water being trapped on the afterdeck. Such a sudden increase in weight at deck level would have raised the centre of gravity of the vessel, which, combined with the free surface effect of the water, would have resulted in a rapid destabilisation of the vessel. Given the low freeboard aft, a wave breaking onto the deck was likely to be the final and main contributing factor to the capsize.

2.6 The problem that necessitated the throttle lever being wedged by a knife could have resulted in the vessel losing speed at a time when it was moving from the relative shelter between the islands into the more exposed sea conditions of Foveaux Strait. Any loss of speed should have been obvious to those on board, but the initial heavy roll to starboard might have been so unexpected that a loss of engine speed could have gone unnoticed in the ensuing commotion. A vessel that lost speed would also lose some steerage and was likely to assume a beam-on aspect to the sea, such a position being the worst attitude for a vessel. It was not possible to determine from the engine instruments what amount of power the engine was producing at the time of the capsize.

2.7 It was not uncommon for commercial vessel operators to use their vessels for pleasure from time to time. However, there was conflict between the definitions contained in the Maritime Transport Act 1994 (which excluded commercial vessels from being pleasure craft) and the recent Safe Ship Management Code of Practice (which prescribed the actions necessary for an owner to use a commercial vessel for pleasure). The owner of the *Kotuku* had not made an entry in his logbook, nor had he informed his SSM company; consequently, the vessel could only be considered to be operating as a commercial fishing vessel and, as such, should not have been carrying passengers.

2.8 The *Kotuku* did not comply with the rules for a commercial fishing vessel in several respects. Even if the owner had complied with the provisions of the Safe Ship Management Code of Practice for him to use the *Kotuku* as a pleasure vessel, there was insufficient lifesaving equipment for the number of persons on board as required by Part 91.

2.9 The Commission is of the view that if a vessel is registered as a commercial vessel then it should at all times be required to meet the appropriate standards for a commercial vessel, regardless of which purpose it is being used for. If it is to be used for another purpose, such as for pleasure, then it should be made to comply with any additional applicable standards. This requirement should be clearly spelt out in the standards, and acknowledged in the SSM system.

2.10 The *Kotuku* was a sample of the ageing inshore fishing fleet in New Zealand. The modifications made to suit modern fishing methods, combined with the age of such vessels and their equipment, made them more prone to failure. This necessitated more stringent inspections and conscientious application of the rules and standards than might be necessary for a newer vessel that had been designed and constructed under contemporary legislation. Regulatory improvements made to the design, construction and regulation of fishing vessels were primarily for new vessels and often were not, or could not be, applied to existing vessels.

2.11 Because the *Kotuku* had not completed the stability test required by the maritime rules, there was no opportunity to determine whether it could safely continue trawling and what safety margins were available when carrying cargo or additional persons.

2.12 No vessel is immune from capsize, regardless of how structurally sound it is or how well it has been maintained, or how inherently stable it is. Every vessel has limits but if the boundaries of those limits are not known then an operator might not know how marginal the operation is. A heavy load on deck in good weather might be survivable; as might a light load in severe weather; yet add in other factors such as entrapped water on or under deck, or unsecured load, and the same vessel might capsize under what would normally seem unremarkable circumstances.

2.13 As a commercial fishing vessel the *Kotuku* had been in the survey system for all but the first 3 years of its life. None of the statutory surveys or inspections had:

- identified the deterioration of the hull fastenings
- identified or noted the saturation of the hull
- identified that the freeing ports and bulwarks did not comply with the maritime rules
- required that the stability test be completed
- noted that a freeboard had not been assigned
- identified the improper installation of the liferaft.

2.14 The deficiencies noted above increased the risk of the *Kotuku* operating near or over its margin of safety. Notwithstanding a vessel owner's obligation to comply with statutory rules and standards, the regulatory system had some responsibility to monitor and enforce standards, not only for single vessels in the system but consistently across the entire industry. The Part 40D review undertaken on behalf of Maritime NZ identified that the deficiencies on the *Kotuku* were representative of similar shortcomings found in the sample group. This would suggest that there was a large population of vessels operating with potential safety issues.

2.15 With the advent of the SSM system and the devolvement of the surveying function, Maritime NZ had given up direct control over the consistency of safety standards across the industry. Maritime NZ had noted this and was taking steps to introduce standardisation across the various SSM companies, but the evidence shows there was still some way to go before there was uniformity in the delivery of the survey function, and buy-in to the safety management philosophy by all stakeholders. Such improvements need to be made in order for the people that crew and travel on vessels such as the *Kotuku* to have some confidence that the industry as a whole adheres to robust safety standards.

3 Findings

Findings are listed in order of development and not in order of priority.

3.1 The *Kotuku* capsized due to the cumulative loss of stability caused by the following main factors:

- modifications to the vessel raising its centre of gravity and reducing its statical stability
- loading of the vessel on the day, creating a stern trim and consequent loss of freeboard aft
- accumulation of water on deck from the sea, causing rapid destabilisation through weight added, reduced freeboard and free surface
- the bulwark freeing ports being closed, not allowing water to shed from the deck.

Other factors that could have contributed to the capsize but were not proven were:

- accumulated water in the bilge of the vessel adding to the free surface
- reduction in directional control due to loss of engine speed caused by a fault in the throttle control
- application of full helm during the rolling sequence just prior to capsize.

3.2 The weather and sea conditions were within what should have been acceptable limits for a well-found vessel of the size and original construction.

3.3 The general condition of the hull of the *Kotuku* was substandard and it should not have passed an inspection. The surveyor should not have regarded the *Kotuku* as fit-for-purpose as a fishing vessel, due to the poor condition of the hull unknown stability characteristics and non-compliant freeing port arrangements.

3.4 The lack of stability data for *Kotuku* meant that the vessel was not compliant with the maritime rules, and meant that an opportunity was lost to identify any limitations the inherent stability of the vessel might place on the operation of the vessel.

3.5 The *Kotuku* was not fit to ply as a pleasure vessel on the day of the capsize because the owner had not followed the correct procedure to change its status from a fishing vessel to a pleasure vessel, nor had he ensured that the correct number and type of lifejackets were on board.

3.6 Every person and entity carrying responsibility for the safe ship management system of the *Kotuku* did not identify, or had identified and did not remedy, the fact that the *Kotuku* was at an elevated level of risk. They were:

- the owner
- any skipper or person in charge of *Kotuku*
- the safe ship management company and its surveyors
- Maritime NZ.

3.7 Evidence shows that there was widespread non-compliance with some maritime rules and codes of practice, and the guidelines associated with them for fishing vessels of less than 24 m in length, and that there was likely to be other such fishing vessels at an elevated level of risk.

3.8 The safe ship management system has suffered from a lack of governance to ensure:

- consistency of standards throughout the industry
- that commercial competition between safe ship management providers did not lead to standards being compromised
- that the required standards were maintained.

3.9 The tool used to identify high-risk vessels, the safety profile assessment number system, had been in operation for 6 years, and even on its third version was still not delivering sufficiently effective and reliable information on which to base an inspection regime.

3.10 Delays in the maritime rule-making and rule changing process had hampered attempts to keep pace with industry change, and attempts to improve the safe ship management system had ultimately contributed to a level of uncertainty within the industry and a general acceptance of non-compliance with standards.

3.11 The inaccessibility of the lifejackets on board, and there being insufficient for every person, placed those on board at unnecessary risk.

3.12 The absence of a lifejacket:

- contributed to the deaths of the 2 persons who escaped from the upturned hull
- reduced the chances of survival of the other 3 persons who escaped the upturned hull and survived
- did not contribute to the deaths of the 4 persons who did not escape the upturned hull.

3.13 There was evidence to suggest that the hydrostatic release unit did operate as designed. Nevertheless, the liferaft did not deploy as it should have, probably because its inherent buoyancy would have forced it into its cradle while the *Kotuku* was floating inverted on the surface. The liferaft being constrained by the cradles, probably prevented it from floating free during the subsequent sinking.

3.14 A liferaft would have significantly improved the chances of survival of those 5 persons who escaped from the upturned hull.

3.15 The alarm was raised almost immediately the *Kotuku* was overdue. However, the speed at which the search was initiated and the momentum it gathered could have been enhanced by the use of dedicated marine radio broadcasts rather than using mobile phones.

3.16 Consumption of alcohol is considered to have been a factor contributing to 2 of the 6 deaths through the accelerated onset of hypothermia and consequent near-drowning experiences. Consumption of alcohol by the survivors put them at an elevated risk of succumbing to the effects of hypothermia, but to what level of risk could not be determined due to the absence of legislation allowing post-accident and incident testing for performance-impairing substances.

3.17 Although it could not be established if the deckhand's ingestion of THC contributed to his death, it is of concern that a crew member ingested a performance-impairing substance while in the course of his duties, regardless of whether the *Kotuku* was operating as a commercial or pleasure vessel.

4 Safety Actions

4.1 Following the loss of the *Kotuku*, Maritime NZ issued 2 safety bulletins and one guidance notice (see Appendix 8) that relate to contributing factors identified in the loss of the *Kotuku*. The first safety bulletin and the guidance notice reminded operators and surveyors of the need for freeing ports and that sliding or locking covers were unacceptable. The second safety bulletin addressed liferaft installation and maintenance.

4.2 As a result of discussions between the Commission and Maritime NZ, a meeting between Maritime NZ and operators of vessels that were intended to be used during the 2007 muttonbird season took place on 8 March 2007. Maritime NZ took the opportunity to advise operators of the preparations they should take and offered to visit and carry out safety checks on the vessels. The meeting attracted 25 attendees, of which 15 were vessel operators. It was estimated that only 2 or 3 vessel operators that took part in the muttonbird season did not attend. Following the meeting the Bluff MSI conducted 9 vessel inspections. The Bluff MSI recommended that further meetings with iwi and muttonbirders take place through the year and that a similar safety campaign should be mounted for the 2008 season.

4.3 In response to the Part 40D review, Maritime NZ had set up a working group to improve compliance with the rule.

4.4 In September 2007, the Director of Maritime NZ distributed an informal consultation document for Maritime Rule Part 21 (Safe Ship Management Systems) and Maritime Rule Part 46 (Surveys, Certification and Maintenance) to key stakeholders. This preliminary consultation was intended to identify potential issues so that they could be addressed at an early stage in order to minimise delays during the public consultation process.

4.5 RFD New Zealand offered to run training workshops in the operation and installation of liferafts for Maritime NZ inspectors and SSM surveyors. RFD also confirmed that the company issued installation instructions with all liferafts whether they be SOLAS approved or not.

5 Previous Safety Recommendations

5.1 On 24 July 2007, the Commission approved for publication occurrence report 05-212 into the restricted limit passenger vessel *Milford Sovereign* loss of directional control in Milford Sound on 20 November 2005. On 2 April 2007, as a result of that report, the Commission recommended to the Director of Maritime New Zealand that she:

009/07 Undertake a full review of the safe ship management system and make changes to ensure the system promotes and effectively regulates a safe and sustainable maritime industry consistently throughout New Zealand.

5.2 On 24 July 2007, the Director of Maritime New Zealand replied:

> MNZ constantly monitors the SSM system, which has been formally reviewed three times since its introduction in 1998. Each review, by independent bodies external to MNZ, found that the philosophy behind the system was sound, and since the system was introduced safety statistics in all commercial maritime sectors have improved. While feedback from the industry indicates solid support for the intent of the system MNZ considers that there is still room for improvement in how the system is implemented and delivered by MNZ and SSM companies.
>
> In line with our continuous improvement policy, a review of the SSM system has been identified as the key strategic priority for MNZ in its 2007-2010 Statement of Intent. MNZ has commenced a programme of work to enhance the sustainability and effectiveness of the SSM system by:
>
> 1. Ensuring that the regulatory framework supporting SSM is robust and appropriate by reviewing the maritime rules that govern its operation. A draft discussion document summarising proposed changes to Maritime Rules Part 21 (Safety Management Systems) and Part 46 (Surveys, Certification and Maintenance) is due for public release in late 2007;
> 2. Complementing existing guidance material (Health and Safety: A Guide; FishSAFE Health and Safety Guidelines; various leaflets) with additional material including a comprehensive resource to support owners in the development of their SSM systems, specific fatigue management material, and health and safety guidelines for passenger and non-passenger operations. This additional material is being progressively released through until December 2007 in association with targeted training material;
> 3. Increasing the amount and quality of formal and informal training and education that is available to all those working in the system, including MNZ and SSM Company staff, surveyors, owners and operators. This training will be supported by the development of a mentor network utilising experienced industry participants to provide support and advice to their peers;
> 4. Reviewing the current capacity and quality of service delivery by both MNZ and SSM Companies in the area of SSM and comparing this with requirements in order to identify and address necessary areas for improvement;
> 5. Allocating additional resources to the SSM team within MNZ to allow for more responsive contact with industry and other stakeholders, along with the provision of personalised assistance where required to owners and operators; and
> 6. Structured auditing by MNZ of SSM service providers.

> This work is being actively progressed and monitored within MNZ. It is also intended to establish an external consultative group to ensure that all industry and other stakeholders remain fully involved with, and aware of, the programme as it is developed and implemented.

The intent of this recommendation is equally applicable to this incident.

6 Safety Recommendations

Safety recommendations are listed in order of development and not in order of priority.

6.1 On 20 March 2008 the Commission recommended to the Director of Maritime New Zealand that she:

009/08 In conjunction with the Ministry of Transport, critically review the maritime rule-making process to identify if there are areas where the timeliness of new and amended rules can be improved.

010/08 Review the policy and procedures for issuing exemptions from compliance with the rules to ensure that safety critical standards are not compromised.

011/08 Make the fitting of bilge alarms mandatory in all vessels.

012/08 Require that where a secondary electrically driven submersible bilge pump is fitted, it meets the requirements as prescribed in Maritime Rule Part 40D 28(6).

013/08 Ensure that the current review of safe ship management, and, the amendments to Maritime Rules Part 21 and Part 46 results in:

- safe ship management companies discharging their responsibilities to ensure their client vessels comply fully with the required standards
- Maritime New Zealand discharging its own responsibilities for the oversight of the maritime industry standards in accordance with the Maritime Transport Act 1994
- owners of vessels discharging their responsibilities to ensure their vessels remain in compliance with the rules at all times.

014/08 Ensure that RFD, and other liferaft manufacturers:

- provide painter securing instructions that reflect the use of a weak link as part of a float free system
- issue clear and unequivocal installation instructions to accompany each liferaft
- Maritime New Zealand to promote the use of manufacturers designed liferaft cradles where available.

6.2 On 28 March 2008 the Director of Maritime New Zealand responded:

009/08 The nature of the rules contract between Ministry of Transport and Maritime New Zealand was independently reviewed in late 2007 to establish what opportunities there were to make the process more timely and effective. The results of that review are in the course of being implemented by the Ministry of Transport.

The Ministry of Transport is also currently seeking Cabinet approval to implement several recommendations from recent independent reviews of the transport rules programmes undertaken by Mary Scholtens QC and Richard Clarke QC.

010/08 Policies and procedures for exemptions have been reviewed and are being finalised. These will be signed off and implemented by the end of April 2008. MNZ is currently using a dedicated resource to oversee the exemptions process and is providing extra administrative support. Exemptions will be analysed to identify any potential rule amendments and to ensure that safety critical standards are not compromised.

011/08 Policy work will be carried out during the 08/09 year to assess whether this recommendation meets the threshold for acceptance by the Ministry of Transport on to the Rule development programme.

012/08 MNZ will issue a Safety Bulletin by the end of May 2008, advising owners, SSM Companies and Surveyors that where a secondary electronically driven submersible bilge pump is fitted it meets the requirement as prescribed in Maritime Rule Part 40D.28(6).

013/08 Once the review is completed and recommendations implemented the results will be evaluated against these goals and objectives. This is anticipated to take place in the second half of 2009.

014/08 Liferaft service stations are currently addressing this issue through presentations at Surveyors Seminars. This will be completed by mid-April 2008. MNZ will issue a Safety Bulletin by the end of May 2008 covering the matters raised in this recommendation. Liferaft service stations will be required to issue this Service Bulletin with all serviced liferafts. MNZ will monitor this process through our regular audits of liferaft service stations.

Approved for publication on 20 March 2008

Hon WP Jeffries
Chief Commissioner

Appendices

Appendix 1 Climatic conditions

A1.1 The forecast for the Foveaux marine weather forecast area issued at 0419 on 13 May 2006, which was valid until midnight that day, was:

> GALE WARNING IN FORCE
>
> Westerly 15 knots rising to northwest 25 knots this morning and to 35 knots in the evening. Sea becoming very rough. Southwest swell 3 metres easing. Fair visibility in early morning showers and in rain tonight.

That forecast was updated at 0911 hours to:

> GALE WARNING IN FORCE
>
> Northwest 25 knots rising to 35 knots this evening. Sea becoming very rough. Southwest swell 3 metres easing. Fair visibility in rain tonight.

A1.2 MetService provided an aftercast of the weather that would have been experienced in the vicinity of Womens Island, Foveaux Strait at the time of the incident as shown below:

> **Situation**:
> At midday Saturday 13 May 2006 a trough of low pressure over the Chathams area was moving eastwards away from New Zealand. Another trough of low pressure with a cold and warm front was approaching southern New Zealand from the west. This trough was associated with a deep depression well to the south of the country. The air stream over the Foveaux Strait area was turning from southwesterly to westerly and steadily increasing in strength.
>
> **Weather conditions:**
> 0900-1800 hours 13 May 2006, near Womens Island, one of the Muttonbird Islands, northeast of Steward Island
> Wind: West to northwest 20 to 25 knots at 0900, rising to 30 to 35 knots at 1600, and then easing again. Near Womens Island at 1400 the wind would have been about 30 knots from the northwest.
> Sea: Significant wave height about 2.5 metres and probable maximum wave height about 3.3 metres in open water, but lower in the lee (shelter) of an island.
> Swell: Probably none detectable, being in the lee of Stewart Island.
> Weather and Visibility: Cloudy to overcast. Good visibility (40 km), but reducing to 3 kilometres in a period of rain between about 1230 and 1330 hours.

A1.3 MetService automatic stations at Southwest Cape, Stewart Island and Invercargill Airport recorded the wind speed and direction as follows:

	Southwest Cape			Invercargill Airport		
Time	Direction	Speed	Maximum Gust	Direction	Speed	Maximum Gust
1200	310°(T)	33 kts	46 kts	350°(T)	9 kts	17 kts
1300	320°(T)	34 kts	52 kts	330°(T)	8 kts	14 kts
1400	320°(T)	42 kts	54 kts	350°(T)	6 kts	12 kts
1500	330°(T)	40 kts	52 kts	010°(T)	6 kts	9 kts

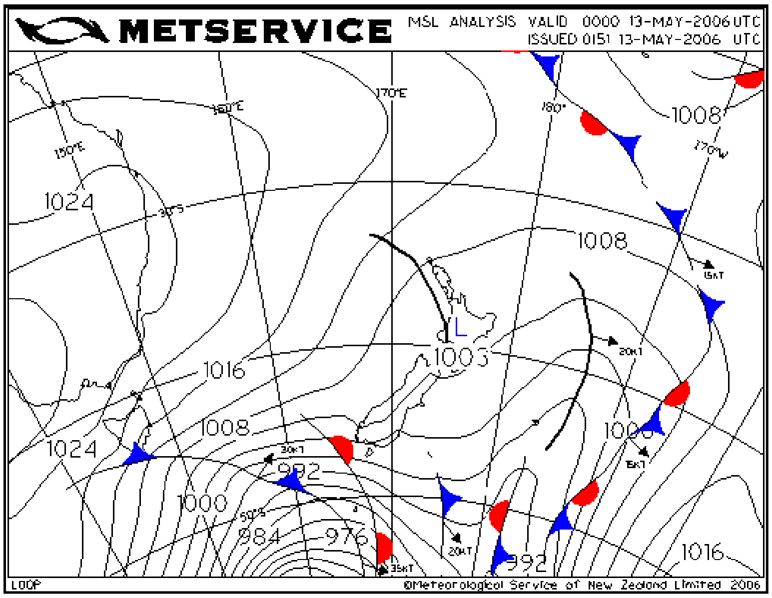


Figure A1.1
Mean sea level analysis for 1800 on 13 May 2006

A1.4 Private weather stations at Bluff and at Oban, Stewart Island and at Makarewa, north of Invercargill recorded the wind speed and direction as follows:

Time	Bluff			Oban			Makarewa		
	Direction	Speed	Maximum Gust	Direction	Speed	Maximum Gust	Direction	Speed	Maximum Gust
1200	288°(T)	14 kts	21 kts	250°(T)	10 kts	15 kts	345°(T)	6 kts	8 kts
1300	334°(T)	14 kts	19 kts	250°(T)	5 kts	6 kts	346°(T)	6 kts	7 kts
1400	300°(T)	8 kts	11 kts	240°(T)	8 kts	12 kts	001°(T)	4 kts	4 kts
1500	298°(T)	7 kts	9 kts	250°(T)	6 kts	14 kts	011°(T)	3 kts	4 kts

A1.5 The helicopter pilot estimated the wind to be northwest 10 knots when he was loading the vessels at Kaihuka, and estimated that it had risen to about 25 knots from the northwest when he was returning to Invercargill in the early afternoon. About 40 minutes before the accident, a charter vessel operator had passed through the area where the *Kotuku* capsized and he estimated the wind to be northwest 15 to 20 knots.

A1.6 The survivors from the *Kotuku*, and people on nearby islands, estimated the wind to be from north to northwest at about 20 knots, with a maximum of 25 knots. The sea conditions were described as a "slight slop" and "nothing to be concerned about".

A1.7 After the accident the Commission contracted the National Institute of Water and Atmospheric Research (NIWA) to produce a wave and tide hindcast for the Womens Island area at the time of the capsize. The oceanographer at NIWA used a simulated WAM wave generation model that used wind data from atmospheric modelling at the National Oceanic and Atmospheric Administration National Centres for Environmental Prediction Ocean Modelling Branch. The WAM model was used to predict the sea conditions at 2 relatively well-exposed sites at the eastern and western approaches to Foveaux Strait. The presence of islands and shoals near the capsize position required a more detailed approach, so a simulating waves nearshore (SWAN) model was used together with the WAM model to produce a series of wave statistics for the capsize area. In Figure A1.2 the red and green lines show the wave characteristics as generated by the WAM model, and the blue line shows the interpolation between the WAM model and the SWAN model to give the predicted wave characteristics at the capsize position.

A1.8 The oceanographer described the heights of waves and the possibility of unusual or rogue waves as follows:

> The significant wave height is the average of the biggest 1/3 of all the waves measured. Say the result was 2.5m. There will have been lots of waves smaller than that, quite a few waves between 2 and 3m, a few in the 3 to 4m range, and ever decreasing numbers in higher ranges. When the actual statistical distribution of wave heights is calculated, it usually follows a standard curve (the "Rayleigh distribution"). This doesn't actually give an upper limit, though: in normal conditions you might expect a wave of twice the significant height about once every few hours, but if you wait long enough you can probably expect one of 3 times the significant height.
> The "maximum wave height" depends on how long you measure for, but if the model gives us the significant wave height, we can estimate the maximum height expected over a certain time, if we assume "normal" conditions (i.e. the Rayleigh distribution probability theory applies).
> This also makes the concept of rogue waves problematic. Some people define a rogue wave as one with a height more than twice the significant wave height prevailing at the time, but from what I've said above, that would include waves which are just at the rarer end of what you expect normally under the standard theory. I'd prefer to say that a rogue wave is an event outside the range of the "normal" theory, in some sense not fitting on the Rayleigh distribution, and suggesting that conditions aren't "normal".

A1.9 From the graphs in Figure A1.2 the interpolation for about 1430 gives the following results:

significant wave height	2.5 m
mean wave period	3.5 seconds
peak wave period	6 seconds
mean wave direction	325° (T)

In his summary the consulting oceanographer estimated the significant wave height to be between 2.0 m at 1200 and 2.7 m at 1600 predominately from the northwest direction.

An operator who passed through the area shortly before the capsize estimated the wave height to be between one and 2 m.

A1.10 The configuration of a sea wave is a combination of its height and its frequency; together these determine the gradient of a wave. As a wave train approaches a shelving sea bottom, the lower part of the wave is slowed by its proximity to the seabed, but the upper part continues to move at its original speed; this reduces the frequency of the wave, which increases its gradient. Eventually, the gradient increases to such an extent that the wave cannot support the crest and the wave breaks. Even before a wave breaks, the gradient can increase to the extent that an approaching wave can form a near-vertical face, which can cause problems to small, less well-found vessels.

A1.11 The predicted tidal data for Bluff, as detailed in the New Zealand Nautical Almanac for 13 May 2006, was:

Low Water		High Water		Low Water	
0748	0.8 m	1357	2.7 m	2012	0.9 m

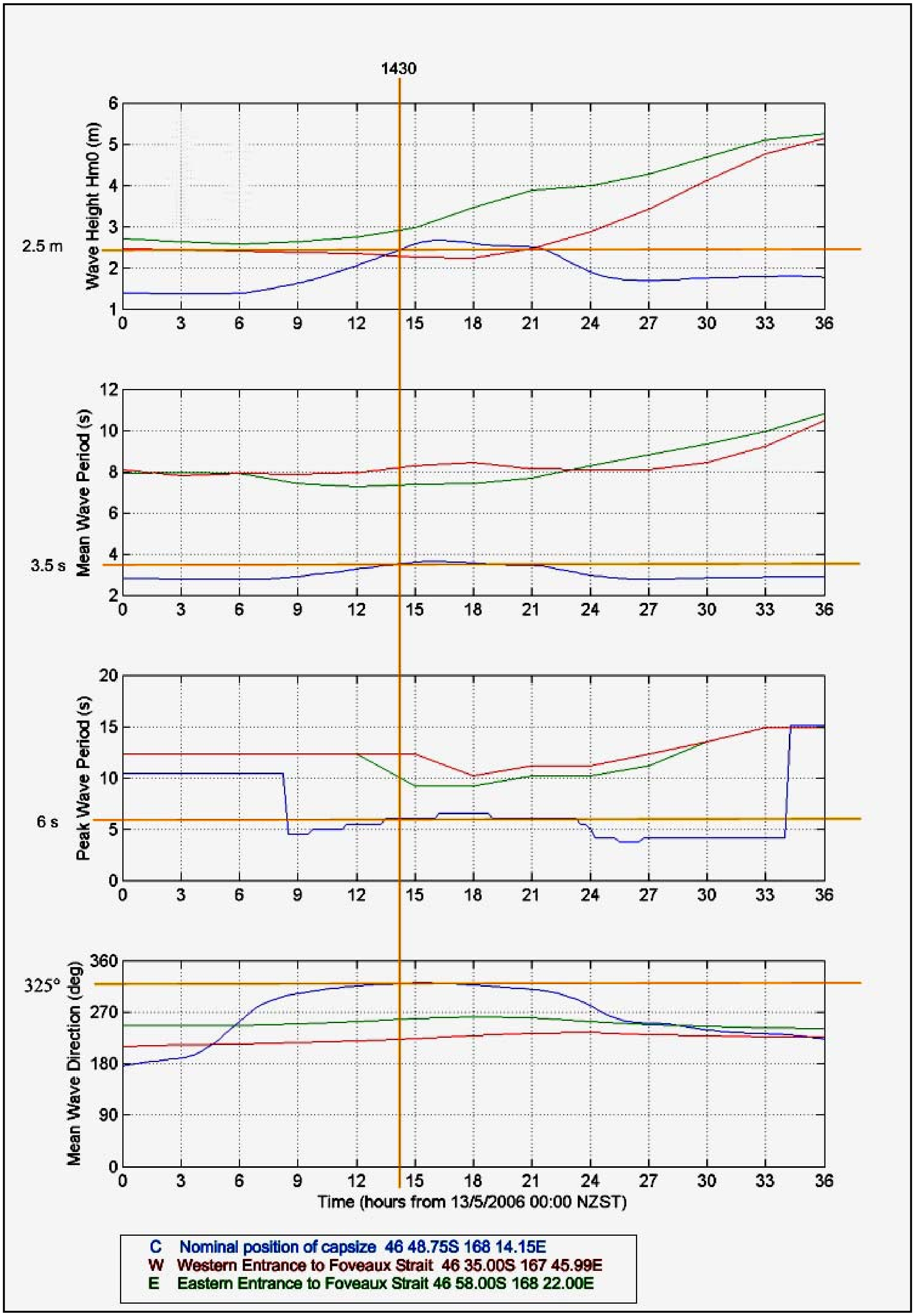


Figure A1.2
Wave analysis from WAM and SWAN models

A1.12 South Port produced and used their own tidal information, which predicted the high and low water slack at the Bluff tide beacon. This was:

Low water		High water		Low water	
0815	0.8 m	1430	2.7 m	2045	0.9 m

Operators who worked in the area estimated that the time of tides at North Isles was between one and 2 hours after that at Bluff.

A1.13 NIWA also modelled the tidal level and the mean current for the area around Womens Island. They determined that at 1400 the current was running in an almost exact easterly direction at a rate of 0.3 knots.

A1.14 The owner and skipper of a vessel that regularly passed close off the western side of North Island reported that, during the latter part of the flood tidal stream, a westerly flowing eddy formed off the northern side of the island, which could cause eddies and overfalls. Eventually this eddy became the ebb tide.

A1.15 A fisherman indicated that in the early 1990s he had experienced a higher than expected wave and associated deeper trough in the area to the west of Womens Island. His recollection was that the weather and tide conditions were similar to those prevailing at the time of the *Kotuku* accident. He described that his vessel rode over one sea but fell into the exceptionally deep trough that followed the sea. The severity of the roll caused batteries in the engine room of the vessel to be displaced and damaged; also, containers secured on the wheelhouse roof were lost. Fortunately, the vessel righted itself and was able to continue into the strait where the water was calmer.

Appendix 2 Safe ship management certificate

SGS M&I

Safe Ship Management Division

Free phone: 0800 103 433

NEW ZEALAND SAFE SHIP MANAGEMENT CERTIFICATE

issued under the provision of rule 21.13(7) or 21.13(11) of Part 21 of the Maritime Rules by

Name of Ship: **Kotuku**

MSA No: **101095**

Home Port: **Bluff**

Gross Tonnage: **26**

Name and Address of Owner:

Length O.A. **14.2**

[redacted]

The above Ship is Fit for Purpose as: **Fishing Ship**

The above ship must not proceed beyond the following operating limits:

Coastal Limits of New Zealand.
Trawling only within 12 miles of the coast of New Zealand.

The above ship must not carry more than the following number of passengers:

Enclosed Waters	**Nil**	*Inshore Limits*	**Nil**	*Restricted Coastal Limits*	**Nil**
Coastal Limits	**Nil**	*Offshore Limits*	**Nil**		

Lifesaving appliances are provided for a total of **3** *persons.*

(all as detailed in the Vessels S.M.S. Manual)

THIS IS TO CERTIFY THAT the Safe Ship Management System of the ship has been audited and that it complies with the requirements of the New Zealand Safe Ship Management Code and that the ship and its equipment remain fit for their intended purpose.

This Certificate is valid until 7 November 2009, subject to periodical audit/inspection of the ship and its management system.

Date of issue **15 February 2006**

Signed ....

Authorised Signatory of SMS Division

Certificate No: **10590/2**

SGS New Zealand Ltd | 43 Church Street P.O. Box 13-518 Onehunga Auckland t +64 9 634 3637 f +64 9 636 6054 www.sgs.com

Appendix 3 Muttonbirding

A3.1 Muttonbirds, or sooty shearwaters, are migratory seabirds that find the outlying islands around Stewart Island to be favourable for nesting and breeding. The birds, known as titi in Maori, are traditionally and exclusively gathered by Rakiura (Stewart Island) Maori and their descendants. There are 36 islands, known as the Titi (Muttonbird) Islands around Stewart Island (see Figure A3.1). The harvest, which was strictly controlled, took place each year between 1 April and 31 May. Muttonbirders were allowed to go to the islands from 15 March to prepare for the season.

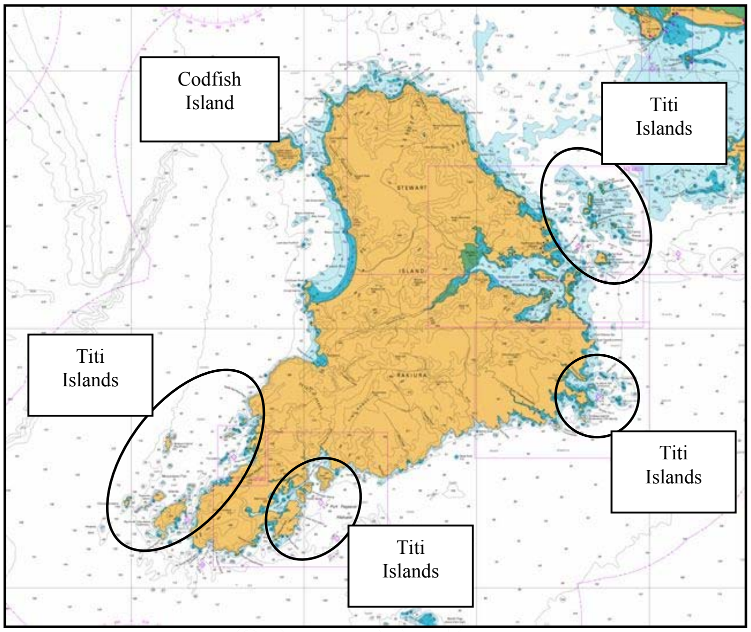


Figure A3.1
The Muttonbird Islands of Stewart Island

A3.2 Muttonbirds were used for food and also as a financial commodity. The harvest of the birds was steeped in culture and had considerable economic significance. The harvest fell into 2 stages: the nanao, which was during the earlier part of the season and required the chicks to be taken from their burrows, usually during the hours of daylight; and the rama, which started in mid-April and lasted to the end of the season. During this period the chicks emerged from their burrows, usually on dark, moonless nights and especially when there was wind and rain, to exercise their developing wings. Torchlight was used to hunt the chicks. The rama harvest was generally quicker and more bountiful than the nanao.

A3.3 Processing the caught birds was labour-intensive and involved plucking, cleaning and preserving them. Some birds were kept fresh or frozen, but the majority were preserved by being salted in 10-litre plastic buckets.

A3.4 The topography of the Muttonbird Islands was generally steep-to with cliffs that rose from the sea. Landing was difficult and dangerous, except at a few islands where there were sheltered landing areas. Traditionally, the muttonbirders and their supplies were landed on the shore by dinghy and they climbed up steep pathways to access the houses that were usually on higher ground. Some muttonbirders still used this method to transfer to and from the islands, but in recent times helicopters had more frequently been used to transfer the supplies and cargo, and, in some cases, like the family that joined the *Kotuku*, the passengers were also transferred by helicopter to an island with a better boat landing.

A3.5 Over the previous 5 years or so, many muttonbirders had used the catamarans that operated the Bluff to Stewart Island ferry service to transfer them and their cargo to the islands. A recent change of ownership of the ferry service had resulted in the new owner no longer making its vessels available to transfer muttonbirders. This had resulted in there being more demand for other vessels, such as the *Kotuku,* to transfer the muttonbirders to the islands.

A3.6 There were a number of operators of passenger and non-passenger vessels working out of Stewart Island and Bluff that were suitably certified to carry both passengers and cargo. They transferred the muttonbirders and their cargo, usually for a fee.

Appendix 4 Recovery

A4.1 In the week following the accident the Commission and Maritime NZ determined that the recovery of the *Kotuku* was necessary to determine the circumstances and causes surrounding the loss of the vessel. Negotiations were entered into with a local contractor who operated the Southport floating crane, a professional dive and salvage company from Wellington and a local vessel operator.

A4.2 By 22 May 2006 the dive team and its equipment were on site in position 46° 48.6'S 168° 40.4'E, where they did a full external inspection of the hull, which was captured on video (see Appendix 5). The video footage was used to determine whether a recovery attempt was viable and also to provide evidence should the recovery fail. The *Kotuku* was found largely intact, lying on its starboard side on a seabed of shingle and shell. A recovery was considered feasible and plans were put in place to start the process the following day.

A4.3 It was recognised that as the working depth exceeded 30 m the divers had restricted bottom-time and needed to take decompression stops as they returned to the surface. So the time available to complete the preparatory work for the recovery would be limited. In addition, the strength of the current at the site was such that the divers could only work for a short period on either side of slack water.

A4.4 Divers worked throughout 23 May attaching straps and airbags to the after part of the vessel. The divers also resecured the lashings on the liferaft so that it did not release during the recovery. Work was abandoned early on this day due to excessive tides and the presence of a large white pointer shark in the area.

A4.5 On 24 May the divers completed the preparatory work, and the inflation of the airbags was started at 1220. At about 1240 the vessel broke the surface, but the air valve on one of the airbags detached and the bag vented itself, allowing the vessel to again sink to the bottom. A diver was able to reattach the valve and the airbags were reinflated. The vessel rose to the surface, hanging vertically below the airbags. It was decided to tow the *Kotuku* in that condition to Port William, a shelving sandy bay on the west coast of Stewart Island, about 3 nautical miles north of Half Moon Bay, before any further attempts to stabilise it were made.

A4.6 On arrival at Port William the vessel was towed into the bay until the bow touched bottom, and the airbags were deflated to allow the vessel to sink and lie on the seabed, once again on its starboard side. The depth was about 15 m, which allowed the divers almost unlimited bottom-time with little or no decompression stops.

A4.7 On 25 May the divers disconnected the airbags and attached strops forward, such that the floating crane was able to lift the vessel. By 1430, the *Kotuku* was on the surface, where portable pumps attempted to drain the hull. However, the damage to the hull was so great that the pumps were unable to overcome the ingress of water. To allow repairs to the hull to be carried out, the wreck was set down at high tide on a sandy beach within Port William.

A4.8 On the beach it was possible to conduct a more thorough inspection. It was found that the damage to the bow of the vessel was considerable and the hull planking was sprung over most of its length, particularly on the starboard side. The collision bulkhead was damaged, so it was not possible to segregate any compartments or make them watertight. Although beached at high tide, the vessel was never high and dry, and the time to work was restricted to low tide, which meant only about one hour a day. Attempts to sheath the hull in greased plywood to reduce the ingress of water did not reduce the flow sufficiently to refloat the vessel. Had it been possible to float the vessel, it is doubtful that the hull would have remained watertight as it was towed across Foveaux Strait.

A4.9 On 28 May the decision was made that any flotation would have to be independent of the original buoyancy of the vessel. A flotation collar of plastic buoys, of the type usually used in the aquaculture industry, was prepared and attached to the vessel (see Figure A4.1). In addition, more buoys were positioned in the fish hold and after hold with their hatches battened down. Cargo separation airbags were also inflated in the forward accommodation.

Figure A4.1
The *Kotuku* with flotation collar attached

A4.10 The flotation collar allowed the vessel to be towed to Riverton, Southland, where a crane was used to lift the vessel from the water and place it onto a transport trailer. The vessel was towed to a secure yard in Invercargill, where it was placed on a cradle.

Appendix 5 Wreck examination

A5.1 From the video inspection of the vessel made by the divers it was possible to identify the following information:

- the vessel was lying on its starboard side at an angle of about 70° from the upright
- the stabiliser paravanes were in the stowed position
- the fish hatch was missing (this was recovered as flotsam); there was no means of securing this hatch. The after stainless steel hatch was ajar but held in place by an athwartships lashing that was made fast to eyes on the hatch coaming
- the liferaft was in its cradle, with the lashings lying clear of it; the HRU was missing except for part of the weak link that was attached to the starboard lashing. There was carpet packing pieces between the liferaft and the cradle. The liferaft painter was intact and attached to the after cradle bearer (see Figure A5.1)

Figure A5.1
Still captures from the diver's underwater video

- the after wheelhouse door was closed but the bolt was not home. The glass from the window in the door was broken. All other wheelhouse windows were intact. The toilet/shower door was in place and closed. The port wheelhouse door was missing
- the engine controls were in the idle ahead position. All the engine gauges except the ammeter were registering zero
- the upper part of the bow was extensively damaged, with the hull planking sprung off the stem. The anchor, its fairlead and the forestay plate were detached from the stem and hanging on the forestay that was still connected to the mast. The deck in the forepart was separated from the hull and, forward of the Sampson post, was angled upwards. There were 2 scrapes in the paintwork on the port bow (confirmed later to be pre-existing damage)
- the port side lifebuoy was missing and the starboard side one was in its cradle
- the remainder of the port hull appeared to be intact
- the rudder was well over to port and there did not appear to be any significant damage to the propeller

- the forward athwartship pond board between the fish hatch and the bulwark was still in place, as was the starboard longitudinal pond board extending back to the net guide on that side. The other pond boards were all missing

- the starboard trawl door was loose and was resting on the seabed

- of the freeing ports that were visible, the 2 on the port side forward and aft of the gantry were closed, the after starboard one was open and the other starboard ones were closed.

A5.2 After the vessel was raised, a very brief inspection of the *Kotuku* was made while it was alongside the floating crane. The main focus at that time was securing the vessel. The liferaft was still in its cradle, having been lashed by the divers prior to lifting the vessel. Once the lashing was removed, investigators from Maritime NZ and the Commission were able to lift the liferaft from its cradle. To extract the liferaft from its cradle took more effort than was required to simply lift its weight. The liferaft was removed from the vessel and sent to Wellington for examination.

A5.3 While the *Kotuku* was on the beach at Port William it lay on its port side at an angle of about 45° with the depth of water in and around the hull dependent on the level of the tide; this restricted the ability to carry out a thorough inspection. The extent of the damage to the starboard side of the vessel caused during the 10 days that it was on the sea bottom was visible. The hull planking, and in particular that in way of the turn of the starboard bilge, had been chafed by the coarse shingle and shell. Most of the planks over the amidships length were sprung and flexed, indicating that some of the internal structures were cracked or broken. Much of the caulking between the planks was missing or displaced. The top edge of the earth plate on the starboard side was coming away from the hull, exposing soft hull planking beneath. The timber of the hull planking, particularly in the chafed areas, was saturated and soft. The damage to the bow appeared to be slightly more than that observed on the underwater video. The deck planking had opened down each side of the wheelhouse.

A5.4 A more detailed inspection was possible once the vessel was on the cradle in the yard. Additional information to that noted in previous inspections or changes due to the recovery process were as follows:

- there was a small nick on the outer edge of one propeller blade

- the external keel-cooling pipes for the engine were intact, as were the internal flexible pipes that connected them to the engine

- there was protective wooden sheathing over the after quarter length of the vessel. One strake of the sheathing was missing and the exposed hull planking was soft, to the extent that a knife easily penetrated to a depth of between 6 and 12 mm

- three of the freeing port covers present on the underwater video footage were missing, as were all the pond boards

- gaps between the deck planking near the wheelhouse were more pronounced and now extended further aft than when sighted at Port William

- the fuel and hydraulic tanks were full of a mixture of diesel oil and seawater

- the hydraulic steering gear appeared to be in good order

- the rudder remained at, or close to, hard to port

- the watertight collision bulkhead forward was extensively damaged and no longer tight

- there was no watertight subdivision, consequently the vessel was common from bow to transom

- the 24-volt submersible bilge pump was situated in the propeller shaft recess in the forward part of the fish hold. A non-waterproof connection block, which was fixed onto the side of the propeller shaft recess, was used to join the integral pump wiring to the wiring of the vessel. The connector block was below the water that was in the propeller shaft recess at the time of the inspection

- the valves for the main deck water and bilge system were set to pump seawater through the deck wash hose

- in the engine room, 2 ex-gas cylinders that had been used as freshwater tanks had broken free from their brackets

- the position of the switches was noted. The engine gauges were all indicating zero except for the ammeter.

Appendix 6 Liferaft and liferaft tests

A6.1 From pre-accident photographs, the HRU had been situated on top of the liferaft between the 2 lashing ropes. The installation instructions provided by the manufacturer of the HRU recommended that a quick release slip should be included in the securing arrangement, to allow for the rapid manual release of the liferaft.

A6.2 On recovery of the *Kotuku*, measurements were taken of the relative positions of the 2 wooden bearers that formed the liferaft cradle before they were removed from the wheelhouse roof. Later, the bearers were mounted on a plywood base so that tests could be conducted.

A6.3 On 22 June 2006, the Pacific-4 liferaft on the cradle was taken to a liferaft servicing facility for examination. It was noted that the liferaft was snug in its cradle when the carpet strips were wet or dry. A new HRU of the type fitted to the *Kotuku* was used to confirm that no other parts of the lashing system had been lost during the accident and vessel recovery. Video and photographs confirmed that the HRU was in place during the accident voyage.

A6.4 The liferaft case was found to be in good condition, with 4 drain holes in its bottom. The painter passed through a hole in the lower case that was made weathertight by a rubber grommet. The 2 halves of the case had tape joining them and were secured by bands around the liferaft. The liferaft casing was weathertight but not watertight.

A6.5 The upper and lower faces of the liferaft case had cruciform indents, which were designed to interlock with companion cradles to provide a secure base on which to store the liferaft. The shoulders of the cradle were curved and quite low, to allow the liferaft to disengage should the cradle be at a large angle. The companion cradles were supplied separately to the liferaft at an additional cost of about $120.

A6.6 The liferaft case was opened by cutting the securing bands and removing the tape between the 2 halves. The vacuum packed plastic bag that contained the liferaft was sealed by a mastic type sealant. The bag appeared to be intact without any noticeable water ingress. The painter and gas bottle operating system was in place and in good order. The liferaft was replaced in its case and new tapes used to secure it.

A6.7 A Surviva-6 RF liferaft, the same type as that condemned on the *Kotuku* in 2004, was measured against the cradle. There was a gap of approximately 60 mm between the sides of the cradle indents and the liferaft case.

A6.8 On 11 July 2006, the buoyancy of the liferaft when the case was flooded was determined by placing it in a tank of water and applying weight to it until the liferaft reached neutral buoyancy. The experiment was carried out by placing the liferaft inverted in a tank of water so that the case could flood through the drain holes and the gland through which the painter passed, so as to simulate what would happen after extended submersion. A total weight of 34 kg was needed to reach neutral buoyancy. A fully charged compressed gas bottle of the type fitted to the Pacific-4 liferaft was also weighed both dry and immersed. Dry it weighed 4.69 kg and immersed 1.53 kg.

A6.9 On the same day, tests were carried out to determine the holding force that the cradle exerted on the liferaft. The underwater video taken by the divers was used as a reference to mount the liferaft on the cradle, ensuring that the carpet strips were in place. A calibrated recording load cell was placed between a hoist and the lifting handles of the liferaft. Three lifts were carried out with the carpet strips dry and a further 3 when it was wet. The dry weight of the liferaft was also recorded. The load cell recorded peak voltages, which were converted to kilograms force. The results and values of holding force are presented in Table 1.

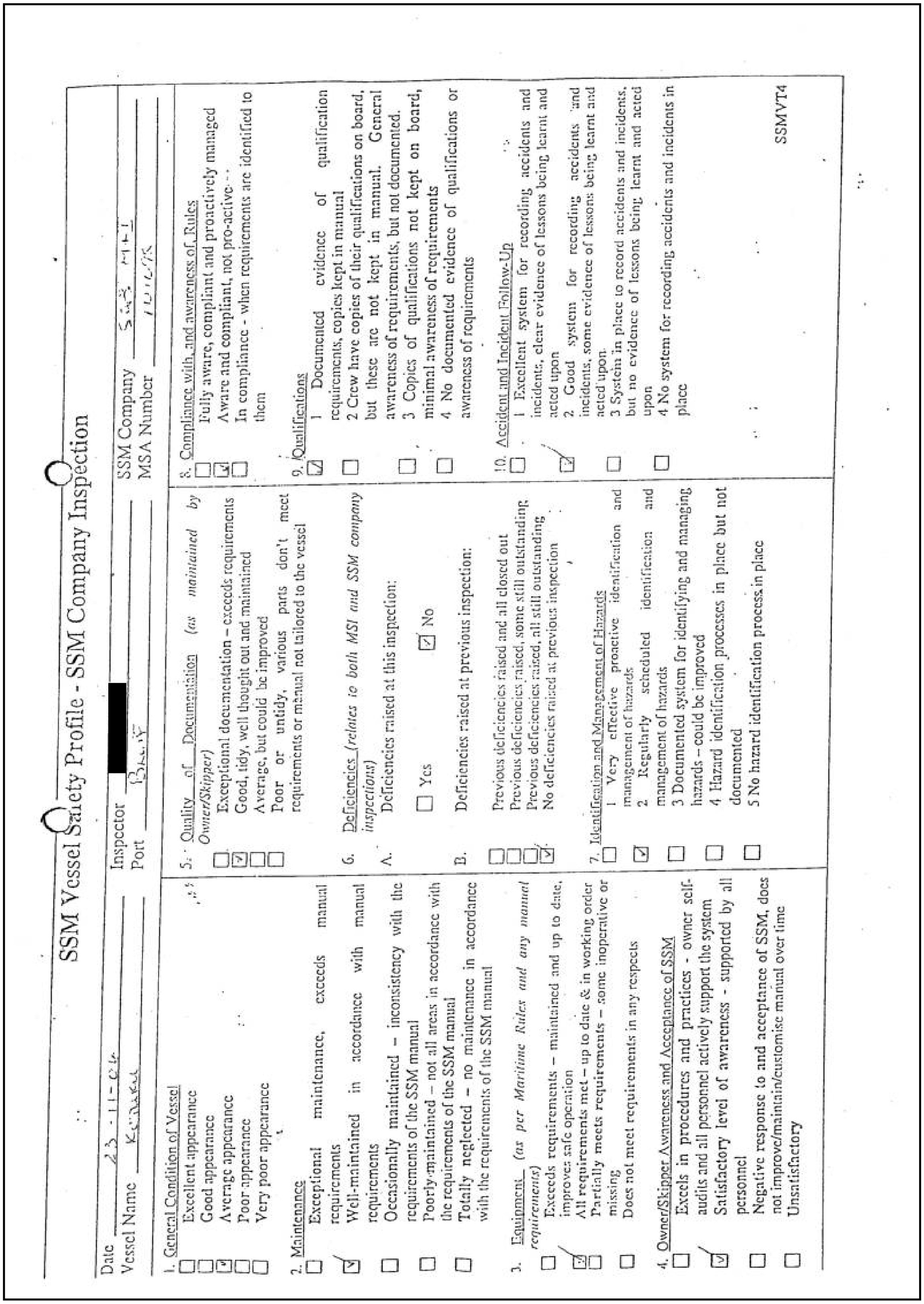
Parameter	1st test kgf (volts)	2nd test kgf (volts)	3rd test kgf (volts)	Average force kgf	Average cradle holding force kgf
Case and liferaft with dry carpet	57.71 (2.223)	59.45 (2.29)	59.71 (2.30)	58.9	19.5
Case and liferaft with wet carpet	62.04 (2.39)	60.48 (2.33)	61.00 (2.35)	61.2	21.6
Case and liferaft suspended weight	39.4 (1.52)				

Table 1

The average force needed to overcome the holding force between the liferaft casing and the cradle was between 19.5 and 21.8 kg depending on whether the carpet was dry or wet, being greater when wet.

A6.10 On Friday 13 April 2007, a test was conducted to determine at what depth the liferaft became neutrally buoyant. The liferaft was hauled down by a rope through a block attached to an anchor on the seabed. At various points the hauling was stopped and the depth checked by a diver. It was evident that as the depth increased the positive buoyancy of the liferaft decreased. Below 20 m the buoyancy of the liferaft decreased to the extent that the diver could easily push it down, but it did maintain positive buoyancy up to 38.9 m, the maximum depth of the test. At that depth the diver was able to disconnect the liferaft from the down haul and maintain his position, but soon the reserve buoyancy of the liferaft started to pull him upward, whereupon he released the liferaft and it rose to the surface.

Appendix 7 SPAN documents



SSM Vessel Safety Profile - SSM Company Inspection

Date 23-11-04
Vessel Name [illegible]
Inspector [redacted]
Port [illegible]
SSM Company [illegible]
MSA Number [illegible]

1. General Condition of Vessel
- [ ] Excellent appearance
- [ ] Good appearance
- [x] Average appearance
- [ ] Poor appearance
- [ ] Very poor appearance

2. Maintenance
- [ ] Exceptional maintenance, exceeds manual requirements
- [x] Well-maintained in accordance with manual requirements
- [ ] Occasionally maintained – inconsistency with the requirements of the SSM manual
- [ ] Poorly-maintained – not all areas in accordance with the requirements of the SSM manual
- [ ] Totally neglected – no maintenance in accordance with the requirements of the SSM manual

3. Equipment *(as per Maritime Rules and any manual requirements)*
- [ ] Exceeds requirements – maintained and up to date, improves safe operation
- [x] All requirements met – up to date & in working order
- [ ] Partially meets requirements – some inoperative or missing
- [ ] Does not meet requirements in any respects

4. Owner/Skipper Awareness and Acceptance of SSM
- [ ] Excels in procedures and practices - owner self-audits and all personnel actively support the system
- [x] Satisfactory level of awareness - supported by all personnel
- [ ] Negative response to and acceptance of SSM, does not improve/maintain/customise manual over time
- [ ] Unsatisfactory

5. Quality of Documentation *(as maintained by Owner/Skipper)*
- [ ] Exceptional documentation – exceeds requirements
- [x] Good, tidy, well thought out and maintained
- [ ] Average, but could be improved
- [ ] Poor or untidy, various parts don't meet requirements or manual not tailored to the vessel

6. Deficiencies *(relates to both MSI and SSM company inspections)*

A. Deficiencies raised at this inspection:
- [ ] Yes
- [x] No

B. Deficiencies raised at previous inspection:
- [ ] Previous deficiencies raised and all closed out
- [ ] Previous deficiencies raised, some still outstanding
- [ ] Previous deficiencies raised, all still outstanding
- [x] No deficiencies raised at previous inspection

7. Identification and Management of Hazards
- [ ] 1 Very effective proactive identification and management of hazards
- [x] 2 Regularly scheduled identification and management of hazards
- [ ] 3 Documented system for identifying and managing hazards – could be improved
- [ ] 4 Hazard identification processes in place but not documented
- [ ] 5 No hazard identification process in place

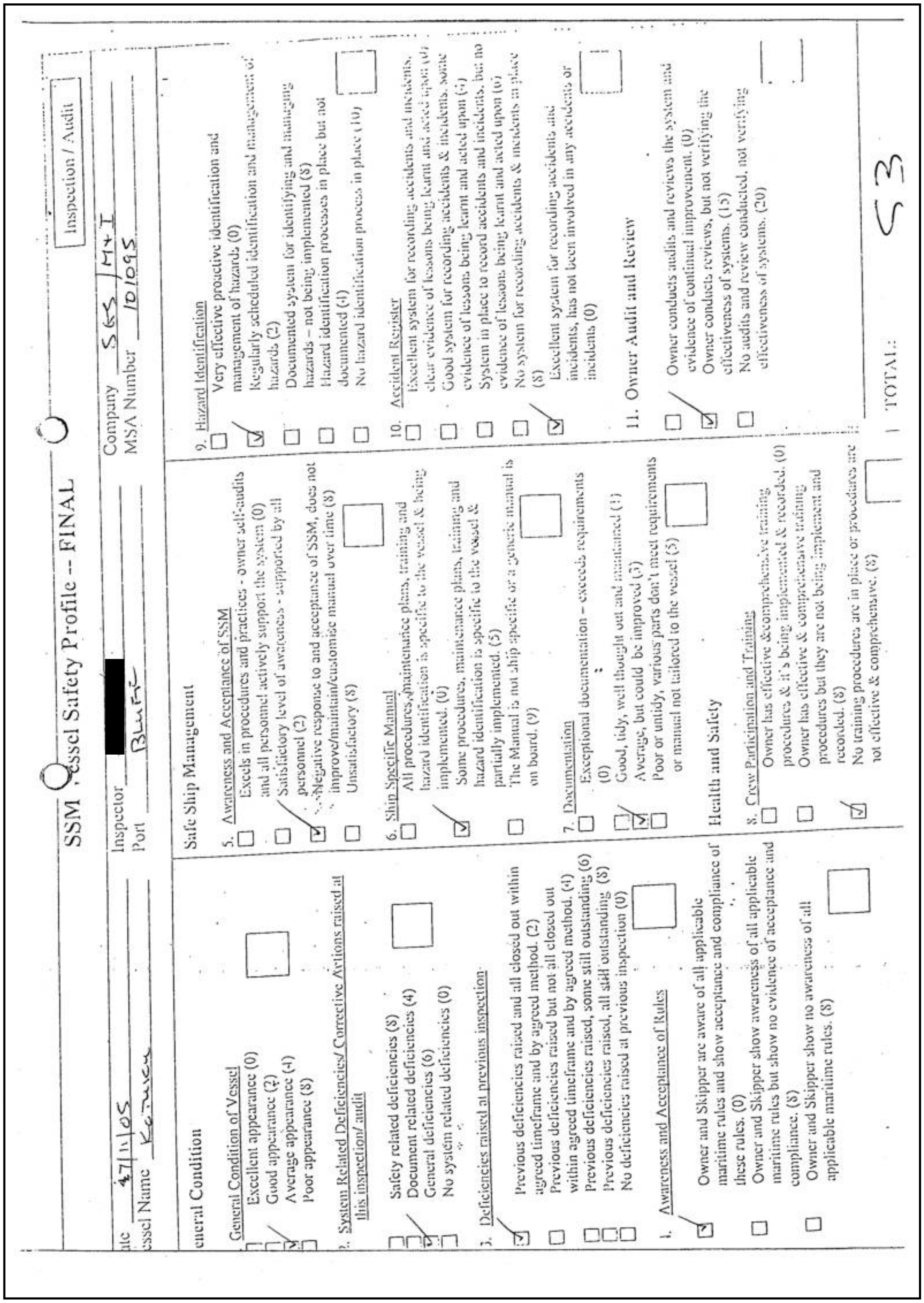
8. Compliance with, and awareness of, Rules
- [ ] Fully aware, compliant and proactively managed
- [x] Aware and compliant, not pro-active
- [ ] In compliance - when requirements are identified to them

9. Qualifications
- [x] 1 Documented evidence of qualification requirements, copies kept in manual
- [ ] 2 Crew have copies of their qualifications on board, but these are not kept in manual. General awareness of requirements, but not documented.
- [ ] 3 Copies of qualifications not kept on board, minimal awareness of requirements
- [ ] 4 No documented evidence of qualifications or awareness of requirements

10. Accident and Incident Follow-Up
- [ ] 1 Excellent system for recording accidents and incidents, clear evidence of lessons being learnt and acted upon
- [x] 2 Good system for recording accidents and incidents, some evidence of lessons being learnt and acted upon.
- [ ] 3 System in place to record accidents and incidents, but no evidence of lessons being learnt and acted upon
- [ ] 4 No system for recording accidents and incidents in place

SSMVT4

Word picture 23 November 2004



SSM Vessel Safety Profile -- FINAL — Inspection / Audit

Date 17/11/05 — Vessel Name Ko[illegible]
Inspector [redacted] — Port BLUFF
Company SGS / M+I — MSA Number 101095

General Condition

1. General Condition of Vessel
- [ ] Excellent appearance (0)
- [ ] Good appearance (2)
- [x] Average appearance (4)
- [ ] Poor appearance (8)

2. System Related Deficiencies/ Corrective Actions raised at this inspection/ audit
- [ ] Safety related deficiencies (8)
- [ ] Document related deficiencies (4)
- [x] General deficiencies (6)
- [ ] No system related deficiencies (0)

3. Deficiencies raised at previous inspection
- [x] Previous deficiencies raised and all closed out within agreed timeframe and by agreed method. (2)
- [ ] Previous deficiencies raised but not all closed out within agreed timeframe and by agreed method. (4)
- [ ] Previous deficiencies raised, some still outstanding (6)
- [ ] Previous deficiencies raised, all still outstanding (8)
- [ ] No deficiencies raised at previous inspection (0)

4. Awareness and Acceptance of Rules
- [x] Owner and Skipper are aware of all applicable maritime rules and show acceptance and compliance of these rules. (0)
- [ ] Owner and Skipper show awareness of all applicable maritime rules but show no evidence of acceptance and compliance. (8)
- [ ] Owner and Skipper show no awareness of all applicable maritime rules. (8)

Safe Ship Management

5. Awareness and Acceptance of SSM
- [ ] Excels in procedures and practices - owner self-audits and all personnel actively support the system (0)
- [ ] Satisfactory level of awareness - supported by all personnel (2)
- [x] Negative response to and acceptance of SSM, does not improve/maintain/customise manual over time (8)
- [ ] Unsatisfactory (8)

6. Ship Specific Manual
- [ ] All procedures, maintenance plans, training and hazard identification is specific to the vessel & being implemented. (0)
- [x] Some procedures, maintenance plans, training and hazard identification is specific to the vessel & partially implemented. (5)
- [ ] The Manual is not ship specific or a generic manual is on board. (9)

7. Documentation
- [ ] Exceptional documentation – exceeds requirements (0)
- [ ] Good, tidy, well thought out and maintained (1)
- [x] Average, but could be improved (3)
- [ ] Poor or untidy, various parts don't meet requirements or manual not tailored to the vessel (5)

Health and Safety

8. Crew Participation and Training
- [ ] Owner has effective &comprehensive training procedures & it's being implemented & recorded. (0)
- [ ] Owner has effective & comprehensive training procedures but they are not being implement and recorded. (8)
- [x] No training procedures are in place or procedures are not effective & comprehensive. (8)

9. Hazard Identification
- [ ] Very effective proactive identification and management of hazards (0)
- [x] Regularly scheduled identification and management of hazards (2)
- [ ] Documented system for identifying and managing hazards – not being implemented (8)
- [ ] Hazard identification processes in place but not documented (4)
- [ ] No hazard identification process in place (10)

10. Accident Register
- [ ] Excellent system for recording accidents and incidents, clear evidence of lessons being learnt and acted upon (0)
- [ ] Good system for recording accidents & incidents, some evidence of lessons being learnt and acted upon (4)
- [ ] System in place to record accidents and incidents, but no evidence of lessons being learnt and acted upon (6)
- [ ] No system for recording accidents & incidents in place (8)
- [x] Excellent system for recording accidents and incidents, has not been involved in any accidents or incidents (0)

11. Owner Audit and Review
- [ ] Owner conducts audits and reviews the system and evidence of continual improvement. (0)
- [x] Owner conducts reviews, but not verifying the effectiveness of systems. (15)
- [ ] No audits and review conducted, not verifying effectiveness of systems. (20)

TOTAL: 53

Word picture 17 November 2005

26-07-07;09:21 ; ;6444941263 # 2/ 2

Safety Profile Assessment Number

01 July 2005

Vessel Name: KOTUKU

MSA Number: 101095

Vessel Type: Fishing Ship

Safe Ship Management Company: SGS/M&I

Safety Profile Assessment Number (SPAN): 7.00

Human Risk Factor: 0
Vessel Risk Factor: 7.00

This is comprised of:

Element	***Highest Possible Risk Score[1]***	***Your Vessel Score***
Complaints	7.00	0
Oilspill History	12.00	0
Inherent Risk	7.00	7.00
Maritime NZ Deficiencies	12.00	0
Maritime NZ Safety Profile Vessel	8.00	0
SSM Company Deficiencies	18.00	0
SSM Company Safety Profile Vessel	11.00	0
Maritime NZ Safety Profile Human	11.00	0
SSM Company Safety Profile Human	14.00	0
Total	*100.00*	*7.00*

This vessel has been assessed as having a **Priority 1** risk level.

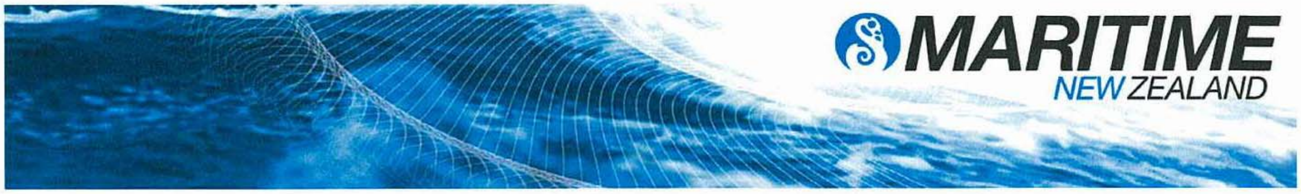
The average SPAN for all vessels in Safe Ship Management is **11.72**.
The average SPAN for all vessels within your Safe Ship Management Company is **10.78**.
The average SPAN for all vessels of a similar vessel type is **14.9**.

The total number of accidents for vessels of your type over the past year is **65**.
The total number of incidents for vessels of your type over the past year is**60**.
The total number of mishaps for vessels of your type over the past year is **1**.
The total number of injuries for vessels of your type over the past year is **24**.
The total number of fatalities for vessels of your type over the past year is **1**

[1] The higher the score, the greater the assessed risk level of the vessel.

SPAN certificate of 1 July 2005

Appendix 8 Safety bulletins and guidance notice



Maritime New Zealand Guidelines

SAFETY BULLETIN ISSUE 7 - 2007

February 2007

FREEING PORT COVERS ON FISHING VESSELS

This Safety Bulletin is for

- safe ship management companies
- ship surveyors
- Maritime Safety Inspectors
- fishing vessel owners and operators
- fishing vessel skippers and crew.

Introduction

A recent review of Maritime Rule Part 40D *Design, Construction and Equipment – Fishing Ships* has highlighted that a considerable number of fishing vessels have blocked freeing ports. The freeing ports are being blocked by sliding covers, locks on hinged covers, or other means.

Imagine being at sea on your fishing vessel at night in bad weather. Water is being shipped on deck and it is dark. Can you be absolutely sure that the sliding covers on your freeing ports have not slipped down and are stopping the water escaping off the deck?

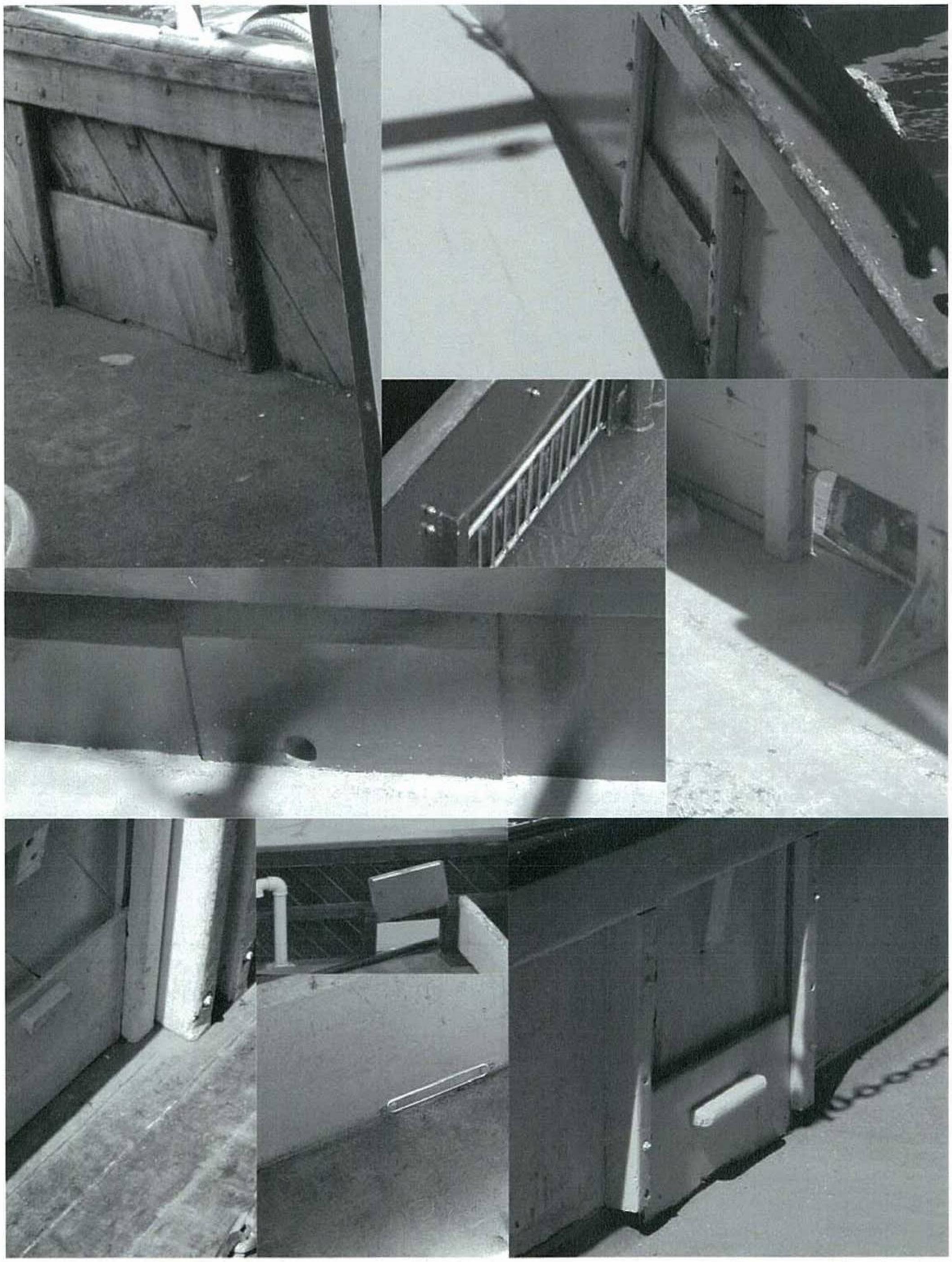
The accumulation of water on the deck reduces stability and exposes the ship and the crew to considerable risk.

It is acceptable to have covers on freeing ports, as long as they are arranged in such a way that they -

DO NOT PREVENT THE RAPID ESCAPE OF WATER FROM THE DECK.

Examples of unacceptable covers are illustrated on the following page.

Examples of unacceptable covers are illustrated below:



Results of water trapped on deck

Water trapped on deck causes:

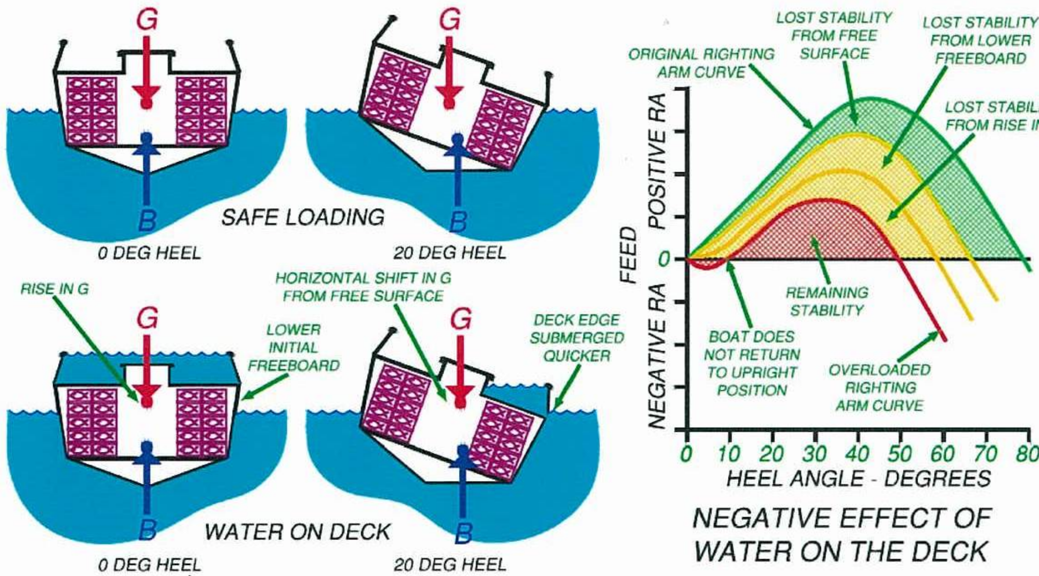
- reduced freeboard
- free surface effect
- loss of stability.

Any combination of these situations will have an adverse effect on the safety of the vessel and that of the crew.

Reduced freeboard

Water trapped on deck is extra weight. It will cause the vessel to sink further into the water and reduce the freeboard of the vessel. As the vessel heels over, the deck edge will be submerged, allowing even more water to come onto the deck. This exaggerates the problem and can result in the rapid loss of the vessel.

The effects of water on deck are illustrated below:



Free-surface effect

The free-surface effect of water trapped on deck dramatically affects the balance (stability) of the vessel. A small amount of water on a deck may not look like very much, however, 100mm of sea water covering a 6m long by 3m wide enclosed deck weighs just under 2 tonnes. As such a vessel rolls, about 2 tonnes of water moves with the vessel on each roll pushing it further over.

As the diagram shows, the free-surface causes a horizontal shift in the centre of gravity (G) of the vessel, reducing the vessels ability to right itself after heeling over.

Loss of stability

Water trapped on deck will also cause the centre of gravity of the vessel (G) to rise due to the extra weight.

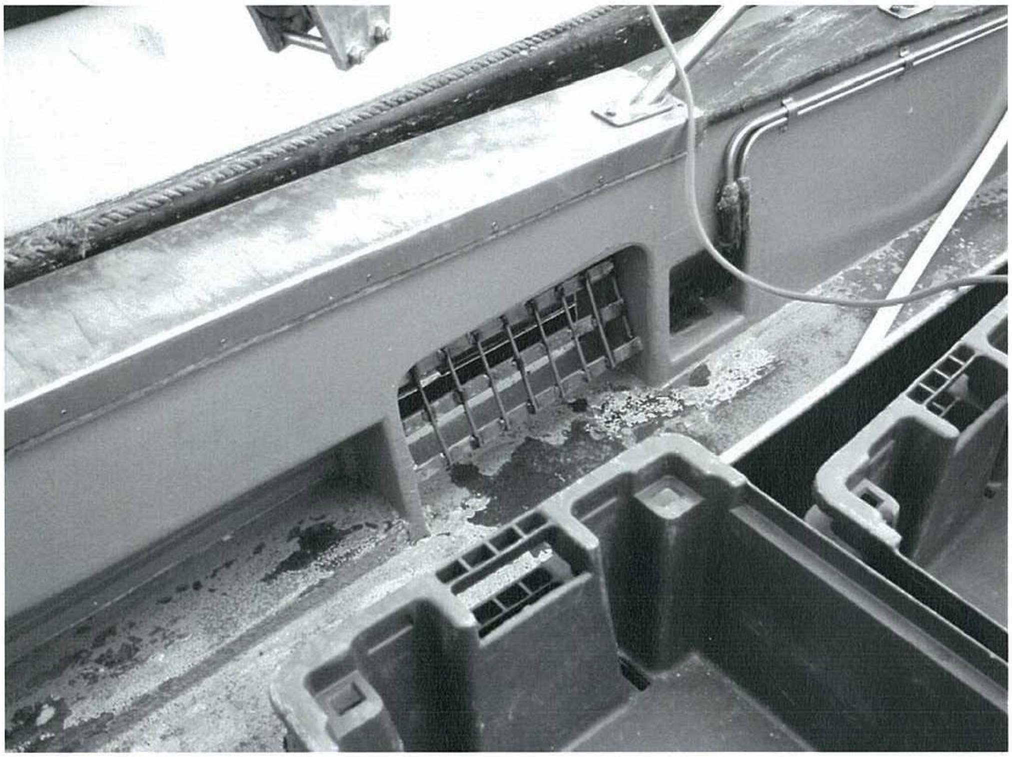
Conclusion

As the diagram shows, the rise of G along with the free-surface effect and lower freeboard will reduce the reserve intact stability of the vessel. This means water trapped on the deck of a vessel that is heeling over will reduce the vessel's ability to return to its normal upright position.

Recommendations/actions

Skippers and crew should review the freeing ports on their vessels taking note of this bulletin.
Options to be considered instead of using sliding covers, include a grill arrangement, as shown overleaf, or hinged flaps that are fitted to the outside of the bulwark structure, allowing water on deck to escape. In this way, the water will be prevented from coming aboard, fish on deck will not be lost and if there is water on deck it can escape as quickly as possible.

A suitable freeing port is illustrated below:



Further Information

For further information, please contact:
Nautical Analyst, Maritime New Zealand
Phone: (04) 4941209
Fax: (04) 494 1263
Email: nautical.analyst@maritimenz.govt.nz

Maritime New Zealand Guidelines

MARINE GUIDANCE NOTICE ISSUE 1 - 2007

May 2007

ADVICE ON ACCEPTABLE FREEING PORT COVERS

This Guidance is for:

- safe ship management companies
- ship surveyors
- Safe Ship Management auditors
- Maritime NZ Maritime Safety Inspectors
- fishing vessel owners and operators.

Introduction

Following the release of Safety Bulletin Issue 7 *Freeing Port Covers on Fishing Vessels* in February 2007, requests have been received from surveyors and Maritime Safety Inspectors for advice on the types of freeing port covers acceptable on fishing vessels.

This guidance note sets out Maritime Rule 40D.23 *Water freeing arrangements*, the details of why and how Maritime New Zealand is enforcing sliding covers on freeing ports, as well as several photographic examples of acceptable freeing ports.

The Rule

40D.23 Water freeing arrangements

(1) Where bulwarks on open weather parts of the working deck form wells, the **minimum freeing port area** (A) in square metres, on each side of the ship for each well on the working deck must be determined in relation to the length *(l)*[5] and height of bulwark in the well as follows -

(a) $A = K \times l$

where: $K = 0.07$ for ships of 24 metres or more in length

$K = 0.035$ for ships of 12 metres or less in length

for ships of less than 24 metres but more than 12 metres the value of k should be obtained by linear interpolation; and

(*l* need not be taken as greater than 70 per cent of the ship's length)

(b) where the bulwark is more than 1.2 metres in average height the required area must be increased by 0.004 square metres per metre of length of well for each 100 mm difference in height; and

(c) where the bulwark is less than 900 mm in average height, the required area may be decreased by 0.004 square metres per metre of length of well for each 100 mm difference in height.

(2) The freeing port area calculated according to rule 40D.23(1) must be increased where the surveyor considers that the ship's sheer is not sufficient to ensure that the deck is rapidly and effectively freed of water.

(3) The **minimum freeing port area** for each well on an open weather superstructure deck must be not less than one half the area (A) given in rule 40D.23(1).

[5] If the bulwark extends for the full length of the well, the length *l* is the length of the well.

Further information about freeing ports

For further information about freeing ports, please contact:
Nautical Analyst, Maritime New Zealand
Phone: (04) 494 1209
Fax: (04) 494 1263
Email: nautical.analyst@maritimenz.govt.nz

Any other queries

For any other queries on Guidance Notice 1, please contact:
Manager Safety Management Systems, Maritime New Zealand
Phone: (04) 494 1225
Fax: (04) 494 1263
Email: manager.sms@maritimenz.govt.nz

MARITIME NEW ZEALAND

Maritime New Zealand Guidelines

SAFETY BULLETIN ISSUE 10 2007

May 2007

LIFERAFTS AND THEIR RELEASE MECHANISMS

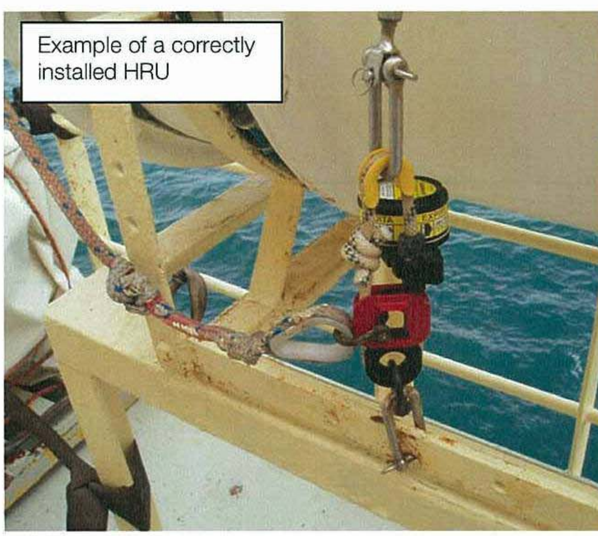
This Safety Bulletin is for:

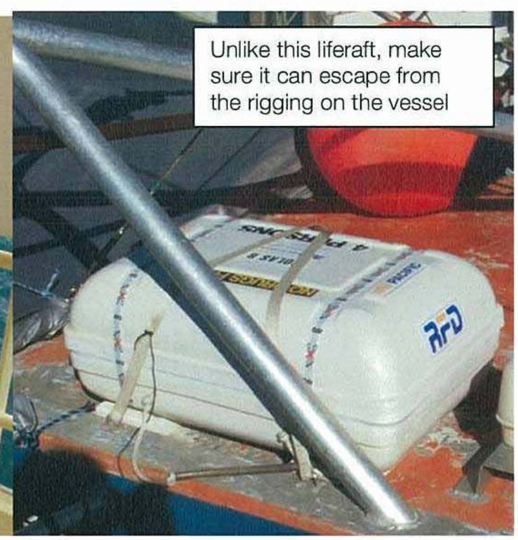
- safe ship management companies
- ship surveyors
- Maritime Safety Inspectors
- owners and operators
- skippers and crew
- liferaft servicing stations.

Will your liferaft save your life?

It is blowing 40 knots, raining, night-time; your vessel is sinking and you have to abandon ship. Your best chance of survival in the freezing sea is a liferaft.
If your vessel capsizes, can the liferaft escape? Make sure the:

- Hydrostatic release unit (HRU) is connected correctly
- Liferaft is not prevented from escaping by extra lashings or rigging on the vessel, or by a cover on the liferaft


Example of a correctly installed HRU


Unlike this liferaft, make sure it can escape from the rigging on the vessel

MARITIME NEW ZEALAND

Common problems with liferafts

Make sure the following happens on your vessel:

- the liferaft is **NOT** stowed in an area where rigging will prevent the liferaft being able to leave the vessel
- the liferaft is **NOT** stowed in a cradle that is too tight to release the liferaft in an emergency
- there is **NO** cover over the liferaft that may stop it from inflating
- gear is **NOT** stowed around the liferaft, making manual operation difficult and reducing the liferaft's ability to deploy
- easy access **IS** provided to the liferaft when it is stored in a difficult location, e.g. the wheelhouse roof.

Manual release liferafts

The manual release on a liferaft is more likely to be used in an emergency than waiting for the hydrostatic release unit to deploy.

Common problems

- Manual release is difficult to operate owing to lack of maintenance or seized parts.
- The liferaft is difficult to get over the side of the vessel because it is obstructed by guardrails or rigging.

Float-free liferafts and the hydrostatic release unit (HRU)

Float-free launching is the method of launching a liferaft whereby it is automatically released from a sinking ship and is ready for use. Float-free arrangements may either be an HRU or some other means. Whatever type it is, if your vessel capsizes too quickly for you to release the liferaft manually the float-free arrangement may be your only chance of survival.

Please see the diagrams at the end of the safety bulletin on the correct installation of an HRU.

Common problems

- The painter is connected to the ship and not the weak link, so the liferaft inflates but goes down with the ship.
- The disposable HRU is out-of-date and will not work.
- The serviceable HRU has not been serviced and will not work.
- The expiry date is not marked on the HRU when it is replaced so there is no record of when to replace it.

Conclusion

In the event of capsizing and/or sinking the liferaft is your best chance of survival.

It is important that:

- every crewmember is trained in how to maintain and deploy the liferaft
- the liferaft is easy to get to for manual release
- the liferaft is stowed in an area clear of rigging and in a cradle that will allow the liferaft to escape
- on float-free liferafts the HRU has up-to-date service and expiry dates.

Recommendations/actions

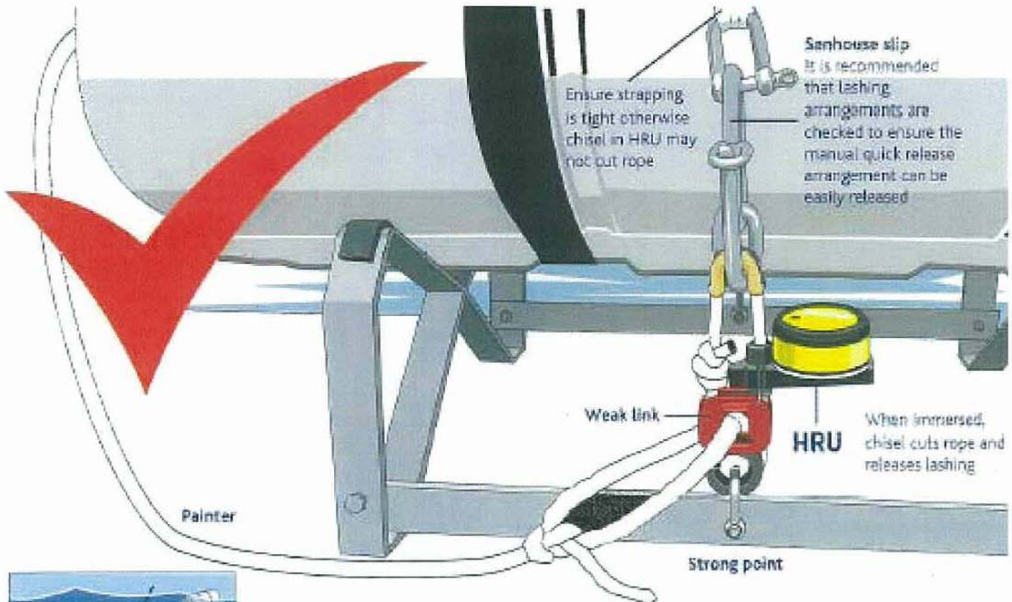
- During maintenance checks make sure your liferaft and its connections are in accordance with the advice in this safety bulletin.
- The procedure for connecting each of your liferafts and how to care for them should be in your SSM manual.

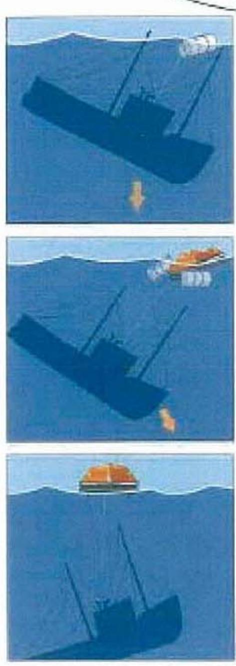
Further Information

For further information, please contact:

Nautical Analyst, Maritime New Zealand
Phone: (04) 494 1209
Fax: (04) 494 1263
Email: nautical.analyst@maritimenz.govt.nz

CORRECT INSTALLATION OF HYDROSTATIC RELEASE UNIT (HRU)

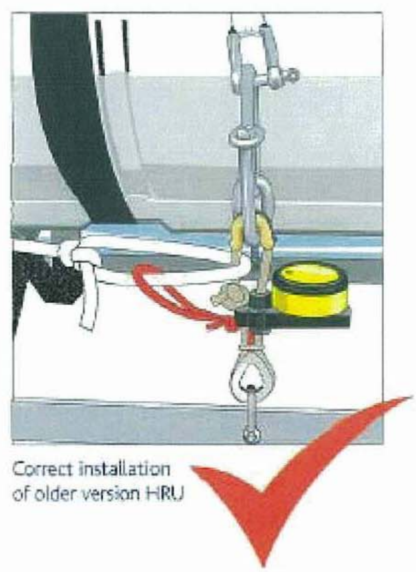




1. If vessel sinks, Hydrostatic Release Unit activates and liferaft attempts to float to surface

2. Tension on painter will cause liferaft to inflate

3. Tension on weak link will cause it to break ensuring liferaft does not go down with the boat



Correct installation of older version HRU

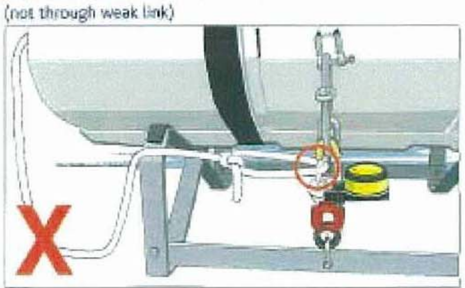
Diagram provided by the UK's Royal National Lifeboat Institution (RNLI)

MARITIME NEW ZEALAND

INCORRECT INSTALLATION OF HRU

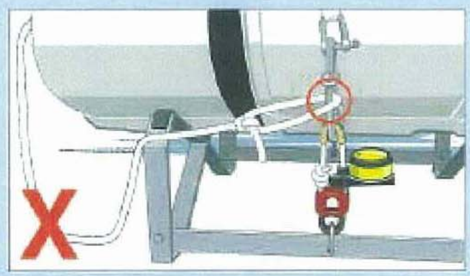
Painter secured to HRU

(not through weak link)



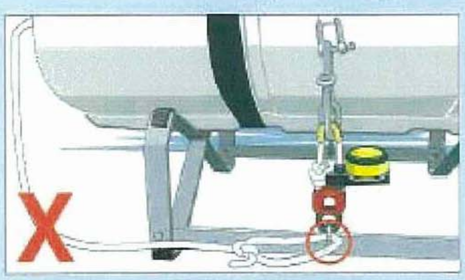
1. HRU will activate
2. Liferaft will be released but will **NOT** automatically inflate and will eventually drift away

Painter secured to senhouse slip



1. HRU will activate
2. Liferaft will float free and eventually inflate
3. Because the painter is secured to the slip, the liferaft will **NOT** be released to the surface

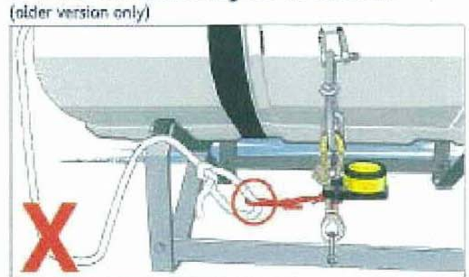
Painter secured directly to strong point



1. HRU will activate
2. Liferaft will float free and eventually inflate
3. Because the painter is secured directly to the strong point, the liferaft will **NOT** be released to the surface **EVEN IF** it is attached to the weak link as well

Painter secured only to weak link

(older version only)



1. Will work correctly for automatic release, but:
2. If liferaft is thrown overboard in an emergency (or comes adrift at sea) it may be lost

Diagram provided by the UK's Royal National Lifeboat Institution (RNLI)

Appendix 9 Fastening and hull planking inspection in October 2007

A9.1 Submissions on the preliminary report questioned whether the sampling process on hull fastenings was sufficiently comprehensive. Even though the number of samples taken exceeded the "8 per side below the waterline" specified in the United States Coast Guard "Guidance on Inspection, Repair, and Maintenance of Wooden Hulls" manual, the Commission elected to conduct further examination of the fastenings and timber. On 29 and 30 October 2007, the experienced boat builder, boat designer and shipwright mentioned in paragraph 1.2.15 and the Commission's investigator took samples of the hull planking and associated internal structures from the below waterline hull at 14 stations on the starboard side and 17 stations on the port side. The majority of the fastenings were removed from the hull planking and frames, but some sections of timber were kept intact. The removed fastenings were examined for corrosion, and measured to estimate the extent of percentage wastage, if any, in the cross sectional area, which would be representative of their loss of strength. The condition of the hull planking and framing timbers was noted.

A9.2 The majority of the bronze nail rove fastenings in the boat were of approximately 4 mm square section, but a number of smaller gauge fastening were identified. The length of the fastenings varied but the majority of the planking nails were about 65 mm from head to rove. All of the fastenings had some degree of corrosion, which varied from surface tarnishing through to complete wastage and failure (see Figure A9.1). A summary of the wastage on the fastenings data is shown in the following table:

	Percentage of wastage	
Port	Percentage	Starboard
3	0%	3
16	Less than 10%	12
2	10% to 19%	17
1	20% to 29%	9
0	30% to 39%	7
5	40% to 49%	5
8	more than 50%	2
35	**Total**	**55**

The average wastage of the fastenings was 26% on the port side and 20% on the starboard side.

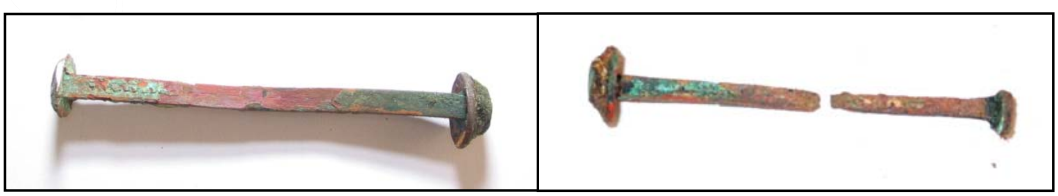


Figure A9.1
Examples of good and wasted fastenings

A9.3 Prior to taking hull planking samples from the starboard side, the sheathing or "quarter badge" was removed. It was usual for tarred felt to be placed between the hull and the sheathing to provide protection from marine worm, but there was none present on the *Kotuku*. The hull planking beneath the sheathing showed extensive signs of decay, leaving the surface of the wood soft and divided across the grain into cubical sections. One butt joint of 2 hull planks that was removed revealed extensive decay in the end timber, the inside face of the hull planking and the butt block behind the joint (see Figure A9.2). Another sample of planking from the after starboard side revealed the onset of decay on the inboard side of the plank.

Figure A9.2
Sample of planking from the starboard side under the sheathing

A9.4 Other general points of note were:

- a sample of a butt block from the forward cabin provided by the owner at the submissions hearing showed evidence of decay. The sample woodwork was matched up to decay in a frame that remained on the vessel

- throughout the vessel the butt blocks were fitted tight between the frames, allowing moisture to become entrapped and thus making it susceptible to decay. Usually, butt blocks were cut short of frames and had their top edges bevelled away from the hull so that any moisture could not become trapped between the block and the frames and hull planking

- behind the fish hold hatch there was close cell foam insulation that was fitted closely to the hull. This prevented good ventilation of the area and allowed the build-up of moisture

- the frames and inner surface of the hull planking at the turn of the bilge in the steering gear compartment and fish hold were wet and impregnated with diesel

- a black deposit was found on the fish hold insulation and wooden members to a height of approximately 0.5 m above the keel, suggesting that it was caused by diesel and lubricating oil contamination from the bilge water

- there were areas where the caulking cotton between the planks was missing, but it could not be determined whether it had been omitted or had rotted away

- paint coverage on the interior surfaces of the hull planking and frames was patchy and so allowed the planks to absorb moisture

- a small amount of flexible sealer was found in some seams near the waterline

- copper oxide had leached into the hull planking and frames at almost every fastening

- there were various grades of kahikatea used in the vessel; some was honey coloured heartwood, but the majority was white outer heartwood or sapwood.

Appendix 10 Report into stability of fishing vessel *Kotuku*

Comparison of separate inclining trials conducted on behalf of the Transport Accident Investigation Commission and Maritime New Zealand.

Contents

Marine Data International Ltd.

Introduction

This report compares the separate inclining trials conducted on the *Kotuku* by naval architects on behalf of the Transport Accident Investigation Commission in July 2006 (the TAIC report) and Maritime New Zealand in September 2006 (the MNZ report). Both trials were conducted out of the water because the vessel's condition made it impossible to conduct a conventional inclining trial afloat.

Measurement origins

Each trial defined the geometry of the *Kotuku* using different longitudinal datums. The MNZ report does not state precisely where the axis for longitudinal dimensions was located, but the diagram on page 9 of that report indicates that this was probably the aft-most extremity of the transom on the centreline. In the TAIC report, measurements, by contrast, were taken about an aft perpendicular located at the centreline of the rudder stock, as shown in the diagram comprising Appendix A of that report. The aft end of the wheelhouse is approximately 6.245 m forward of the rudder stock on this diagram (dimension scaled) and 7.59 m forward of the MNZ report datum (dimension stated on page 8 of the MNZ report). The dimension between the two datums is therefore approximately 1.345 m.

Vertical dimensions in both reports are about a baseline coincident with the underside of keel. However, in creating the geometry of the hull, the diagram on page 12 of the MNZ report indicates that, for the purposes of the stability analysis, the vessel model was trimmed upward at the bow by 2 degrees, the trimming point being the aft-most point of the keel. This is often considered normal practice when producing stability booklets for vessels with a designed rake of keel relative to the datum waterline, as the profile diagrams depicting the vessel in the stability booklet then show the vessel close to its normal trim, rather than trimmed down by the bow. However, in producing an accident report for a vessel where a lines plan is not available, it is generally easier to leave the vessel in the trim at which it was measured, otherwise corrections have to be made to vertical dimensions which were taken or calculated relative to the baseline. In this instance, the correction is the product of the dimension's distance from the aft end of the keel and the tangent of the keel rake relative to the baseline, i.e. 2 degrees.

It is understood that the vessel had twisted significantly by up to 2.2 degrees during the recovery and testing of the vessel. The centreline of the hull, which would be planar in an untwisted vessel, must also therefore be considered twisted. It follows that transverse dimensions locating centres of mass and buoyancy in relation to the centreline must be defined with care.

Condition of the vessel

The *Kotuku* was clearly in such poor condition that a conventional inclining trial afloat was out of the question. The photographs show a vessel which was not watertight and could not therefore be refloated. Both trials were further hindered by the weakness of the vessel's structure, which had been significantly damaged during the course of the accident and recovery. As a result, there was a justifiable reluctance to heel the vessel to higher angles for fear of further damage that might result to its structure. Given this, the reports indicate that both trials were conducted carefully in difficult circumstances.

Use of load cells for dry inclining trials

Both trials used load cells for measurement of the vessel's mass. It is self-evident that the accuracy of such units is absolutely essential if reliable results are to be obtained. Accuracy will depend on the sensitivity of the unit as manufactured and on a calibration check prior to use.

Neither of the sets of load cells had been calibrated immediately before they were used for the inclining tests. Those used for the MNZ test were 3 years old and had been used 3 times before; they had been last calibrated when they had been purchased. Those used for the TAIC test had been calibrated in July 2003 and had not been used again until the *Kotuku* test; after the test, the load cells were recalibrated and found to be accurate. Since then they have been re-certified, with no correction required.

Trial results

The results of the two trials are tabulated below:

	Vessel mass kg	*LCG – metres @ C/L rudder post*	*VCG - metres @ keel line*	*TCG – metres @ C/L*
TAIC	26,600	5.610	1.895	0.029
MNZ	25,670	5.661	1.668	Not calculated
Difference (%)	930 kg (3.6%)	0.051 m (0.9%)	0.227 m (13.6%)	-

The 3.6% difference between the two vessel mass figures is not large, but is a little surprising, given that load cells were used by both companies. Provided these are properly calibrated, a more accurate reading of weight should be obtainable than that from a conventional inclining trial afloat where establishing the exact position of the waterline and hence the displaced volume can be difficult. It is understood that some of the weight difference was probably due to the drying of items such as bedding and insulation that had been saturated at the time of the TAIC trial. However, whilst it is accepted that the timber structure had absorbed a significant amount of additional water due to the prolonged immersion (the TAIC report estimated this at 950 kg, the MNZ report at 874 kg), it is considered that there was insufficient time between the 2 inclining trials (2 months) for the vessel's mass to change significantly through water loss.

The values calculated for the longitudinal centre of gravity are very close, indicating to an extent that the principles employed by both companies, though very different, were sound.

Unfortunately, however, the 13.6% difference between the values calculated for the VCG is very significant and makes a profound difference to the vessel's statical stability. Both the reports bear witness to this: the TAIC one showing that the vessel does not comply with the stability requirements by a significant margin, the MNZ one showing that it does comply.

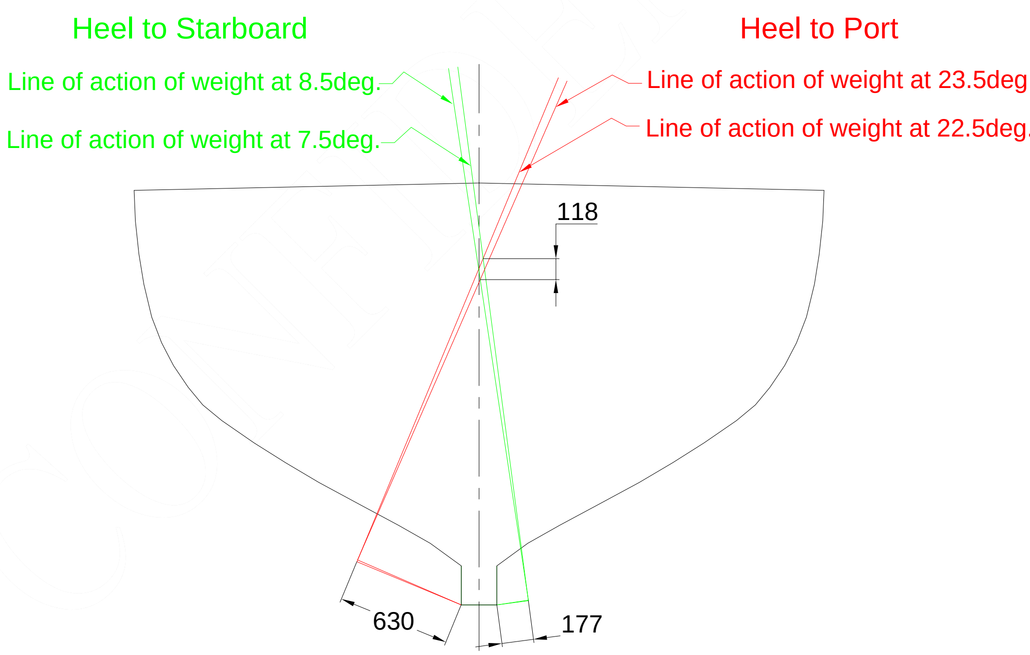
Inclining trial conducted on behalf of the Transport Accident Investigation Commission

This trial was conducted by placing the vessel at a known angle of heel (8 degrees to starboard and 23 degrees to port) on four load cells, arranged as described in Appendix F of that report. The weight readings taken from these load cells, the dimensions locating the cells, the products of these values and the resultant mass LCG and TCG values are tabulated in Appendix E of the TAIC report.

From the photographs of the starboard inclining test it is apparent that the location of the load cells relative to the selected datums could be determined with sufficient accuracy to ensure good results. It was unfortunate that the port aft load cell malfunctioned during the incline to starboard, as a correct figure from this cell would have provided a useful cross reference on the 26,600 kg total mass recorded during the incline to port – it is assumed that the calculated figure of 5,805 kg was obtained by working backwards from the total mass.

The principle behind a dry inclining on a quayside is similar to its more conventional alternative afloat – the vessel is heeled, and data is recorded in this condition. However, as the TAIC report explains in footnote 4 to paragraph 3.1, the 2 differ significantly in one key respect: the angle of heel in a waterborne trial must be limited to ensure accuracy, whereas in a dry trial greater accuracy will generally be achieved by heeling the vessel to larger angles. The greater the heel angle, the less acute will be the angle between the two lines of action of the weight and the less sensitive the intersection point will therefore be to small variations in angle.

In this context, it is noted that the angles to which the vessel was taken are round numbers – precisely 23 degrees to port and 8 degrees to starboard. These figures may be correct, but since it must have been difficult setting the vessel up, there must be some question as to whether these angles are accurate. It is worth noting that a ½ degree variation in both port and starboard values could have resulted in a range of up to 118mm in the vertical CG position – see diagram below.



It is entirely understandable, given the hull's particular fragility on the starboard side, that the heel angle to that side had to be limited to 8 degrees – a greater angle might have increased hull distortion, reducing the accuracy of the trial and risking a serious failure of the weakened hull structure.

Nevertheless, the limited heel angle to starboard must inevitably have reduced the accuracy of the trial, and it is noted that, having calculated a figure of 1.895 m, the author then qualified this by considering the VCG to lie between 1.80 and 1.95 m above the keel line. This 8% variation represents a significant range - certainly more than would be wished in trying to determine the cause of an accident. Again, it is understandable but unfortunate that only 2 heel angles were assessed, one to port and one to starboard. This meant that only one estimate of the CG location could be made. Usually, a trial will be conducted at a number of angles so that a degree of consistency can be observed, giving a degree of confidence in the resultant average CG location.

Similarly, the way the vessel was set up on the load cells meant that it was very difficult, if not impossible, to repeat a test and check the recorded values.

The result of the trial is presented in section 5 above. It is assumed that the TCG was calculated with reference to a centreline plane related to the rudder post, not to the sections forward of this which were twisted by up to 2.2 degrees to starboard. An explanation for this TCG is provided in the report, but it is worth noting that the twist in the hull would also have contributed to this starboard TCG.

The centre of gravity location calculations in Appendix E of the TAIC report have been checked and are repeated in the table below.

Incline to Port

Location	*Mass - kg*	*LCG - m*	*LMT- kg.m*	*TCG - m*	*TMT - kg.m*
Port aft	4440	2.200	9768	0.000	0
Stbd aft	6520	2.200	14344	0.000	0
Bow	6530	10.495	68532	0.000	0
Port bilge	9110	6.235	56801	1.840	16762
Total	26600	5.618	149445	0.630	16762

Incline to Stbd

Location	*Mass - kg*	*LCG - m*	*LMT kg.m*	*TCG - m*	*TMT - kg.m*
Port aft	5805	2.340	13584	0.000	0
Stbd aft	8455	2.340	19785	0.000	0
Bow	9320	10.600	98792	0.000	0
Port bilge	3020	5.580	16852	1.556	4699
Total	26600	5.602	149012	0.177	4699

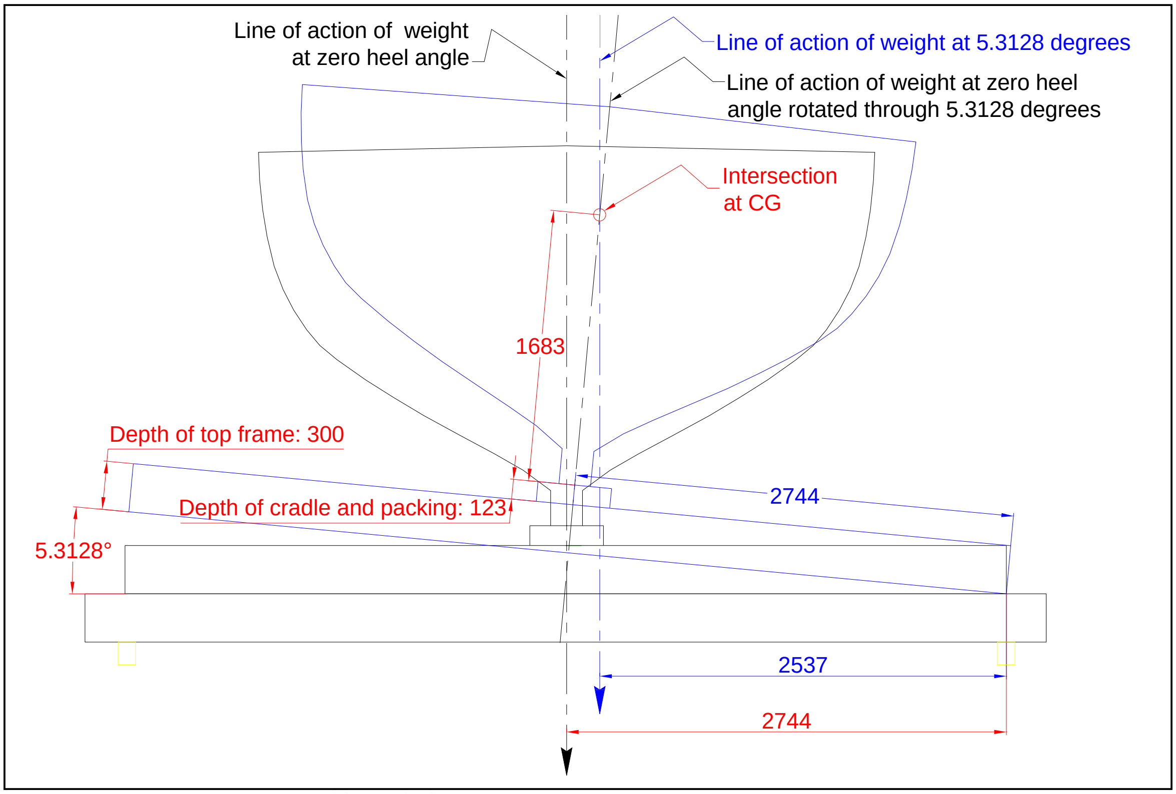
There are no errors apparent in these calculations.

Inclining trial conducted on behalf of Maritime New Zealand

The MNZ trial was conducted in a significantly different manner. Instead of placing the vessel directly onto the load cells, a test rig was constructed with an upper and a lower frame, the latter being supported on load cells. The vessel was supported in a cradle mounted on the upper frame, which could be heeled along with the vessel about hinge points on one side of the lower frame. This had the advantage that, when the rig's top frame was inclined, the vessel's angle of heel could be measured very accurately – this figure is recorded on page 10 as 5.3128 degrees to port. In principle, therefore, it had the potential to be more accurate than the system employed in the TAIC trial. It also had the merit of repeatability, so that results could be checked and a degree of confidence taken in their accuracy.

However, it is most unfortunate that it was not considered possible to increase the heel to port beyond 5.3128 degrees, or to consider an inclining to starboard, presumably because of the fragility of the hull on that side. This meant that the angle between the intersecting lines of action of the weight was a very low 5.3128 degrees – by contrast, this angle was 31 degrees in the TAIC inclining. The effect this had was to make the MNZ VCG calculations very sensitive to minor variations in load cell readings. For example, the correction of a very small 15 kg error made in calculating the average inclined rig mass has the effect of reducing the transverse centre of gravity by 2 mm, but in turn this has the effect of increasing the VCG by a disproportionate 15 mm.

The diagram below illustrates the principle by which the VCG was calculated in the MNZ report. Note that the CG is shown at its corrected location.



The load cell reading for the level mass measurements for the rig vary by between 6% and 22%. It is noted that these variations reduced when the rig was inclined without the vessel, and generally reduced further when the vessel was placed on the rig.

Nonetheless, the disproportionate effect that small variations in load cell readings even on the rig alone could have on the VCG because of the small angle through which the vessel was inclined was described in the final paragraph on page 4 and is emphasised again.

Conclusion

This was a particularly difficult trial for both companies to conduct because the vessel had been badly damaged during the accident and recovery and it was therefore not possible to heel it as far as would have been wished, particularly to starboard. Reasonably consistent figures were obtained from both inclinings for the vessel mass and longitudinal centre of gravity, the differences in the calculated values being 3.6% and 0.9% respectively. Unfortunately, the same consistency was not apparent in the values calculated for the vertical centre of gravity, which differed by 13.6%.
The VCG value calculated for TAIC was inconclusive, principally because the measurements were not or could not be repeated to confirm their accuracy; whilst the

value calculated for MNZ was inconclusive, principally because the vessel was not heeled to starboard to obtain a less acute intersection angle between the lines of action of the weight. The statement on page 6 of the TAIC report proposing a significant 0.15 m range for the VCG (from 1.8 to 1.95 m) was an honest reflection of this, but cannot give confidence in the calculated value. It is regrettable to report that the accuracy of the inclining data recorded in both reports must therefore be questionable.

The calculations deriving the mass and the centre of gravity from this data have been repeated. No errors were found in the calculations of the TAIC report. Small errors were found in the calculations of the MNZ report which highlighted the sensitivity of that trial data but did not make a significant difference to the outcome. The 13.6% difference between the calculated values for the VCG can therefore be explained, but cannot be resolved.

Recent Aviation Occurrence Reports published by the Transport Accident Investigation Commission (most recent at top of list)

07-201	charter catamaran, *Cruise Cat*, collision with navigational mark, Waikato River entrance, Lake Taupo, 22 February 2007
06-208	fishing vessel *Santa Maria II*, engine room fire, L'Esperance Rock, Kermadec Islands, 10 December 2006
05-212 Incorporating	restricted limit passenger vessel *Milford Sovereign,* loss of directional control, Milford Sound, 20 November 2005 incorporating:
06-206	restricted limit passenger vessel *Fiordland Navigator,* heel due extreme wind gust in Milford Sound, 8 July 2006
06-201	passenger freight ferry *Aratere*, Heavy weather incident resulting in cargo shift, Cook Strait, 3 March 2006
06-205	fishing vessel, *Lady Luck*, collision and subsequent foundering, Motiti Island, Bay of Plenty, 23 June 2006
06-203	fishing vessel *Venture*, grounding, Tipi Bay, Tory Channel, 19 April 2006
05-211	container ship *Spirit of Resolution,* collision with bridge, Onehunga, 8 October 2005
05-210	restricted limit passenger vessel *Milford Mariner*, engines' stall resulting in grounding, Harrison Cove, Milford Sound, 18 September 2005
05-208	passenger freight ferry *Santa Regina*, near grounding, Tory Channel eastern entrance, 9 June 2005
05-207	freight and passenger ferry *Santa Regina* and private launch *Timeless*, collision, off Picton Point, Queen Charlotte Sound, 2 May 2005
05-206	passenger/freight ferry *Arahura*, loss of propulsion, Cook Strait, 24 April 2005
05-205	restricted limit passenger vessel *Black Cat*, control cable failure and collision with rock wall Seal Bay, Akaroa Harbour, 17 April 2005
05-202/204	passenger freight ferry *Aratere*, steering malfunctions, Wellington Harbour and Queen Charlotte Sound, 9 February and 20 February 2005
05-201	passenger ferry *Quickcat* and restricted passenger vessel *Doctor Hook*, collision, Motuihe Channel, 4 January 2005

Price $62.00 ISSN 0112-6962