Final Report

Into the capsize and foundering of the

Single outrigger passenger ferry

Uean Te Raoi II

Off Maiana Island in the Republic of Kiribati

13 July 2009

Prepared by the Transport Accident Investigation Commission

For

The Government of the Republic of Kiribati

25 February 2010

Introduction

The accident involving the Kiribati inter-island passenger ferry *Uean Te Raoi II* occurred at around midday on Monday 13 July 2009. The accident was first reported to local authorities at around 1600 hours that same day by one of the occupants from the stricken vessel who had swum ashore to Maiana Island. It was not for some 4 days after the accident, when other survivors were pulled from the water by local fishing boat crews, that the true consequences of the accident were realized.

The Government of Kiribati on 23 July 2009, made a request through the New Zealand High Commissioner to Kiribati for New Zealand to provide expert assistance to inquire into the circumstances of the accident.

The Transport Accident Investigation Commission (the NZ Commission) has, among other functions, the function under Section 8(e) of the Transport Accident Investigation Commission Act 1990 to *co-operate and co-ordinate with other accident investigation organizations overseas, including taking evidence on their behalf*. Pursuant to this section the NZ Commission agreed to provide such assistance, and on 28 July 2009 a team of 3 investigators arrived in Kiribati to start assembling the facts around the accident.

On 30 July 2009, the Kiribati Government by virtue of Section 3(1) of its Commissions of Inquiry Ordinance (Cap. 10) formed a Commission of Inquiry (the Kiribati Commission) headed by 2 Commissioners and assisted by one Secretary to the Commission, one Counsel to the Commission, and 3 experts, the latter being the NZ Commission team.

The terms of reference for the Kiribati Commission were set as follows:

a) Investigate, examine and analyse the circumstances leading to the capsizing of the vessel *Uean Te Raoi II* on Monday 13 July 2009,

b) Investigate and determine the respective roles played in the incident by the proprietors, management and crew of *Uean Te Raoi II*; the Director of Marine and staff of the Marine Division of the Ministry of Communications, Transport and Tourism Development; and any other person considered relevant,

c) Review, examine and evaluate the effectiveness of existing response mechanisms to search and rescue operations, including the effectiveness of actions taken after similar marine incidents in the past,

d) Determine whether the law may have been contravened and recommend where appropriate, proper remedies,

e) Make recommendations as to improvements that might be made to legislation, regulations and licensing conditions so as to strengthen compliance and minimize the occurrence of such incidents in future,

f) Make recommendations as to improve existing policies, processes and procedures so as to improve the effectiveness of search and rescue operations in the future, and

g) Investigate, evaluate and report on whether there exist any other issues of concern in relation to the capsizing of the *Uean Te Raoi II*.

A series of 3 public hearings were convened; 2 on the Island of Tarawa on 3 and 5 August 2009 and one on the island of Maiana on the 4 August 2009.

The Kiribati Commission was given 30 days from the commencement of its inquiry on 30 July 2009 to submit its written report to the Kiribati Government on the result of its inquiry (by 29 August 2009).

Because of the short time frame to complete the report, and the broad and potentially complex nature of the circumstances to be inquired into, an agreement was reached for the NZ Commission to produce a shortened interim report laying out the factual information gathered so far and any possible analysis of it, together with any early safety recommendations to address any identified safety issues.

One of the recommendations in that report was for the Kiribati Government to agree to receive at a later date this full and final investigation report prepared by the NZ Commission once the full investigation had been completed.

Photograph courtesy of M. Savins

***Uean Te Raoi II* prior to launching**

Contents

Figures

Abbreviations

°	degree(s)
%	percent
AMSA	Australian Maritime Safety Authority
AUD	Australian dollars
C130	Lockheed C130 Hercules transport aeroplane
CB	citizen band
GRT	gross registered tonnes
EEZ	exclusive economic zone
EPIRB	emergency position indicating radio beacon
Kg	kilogram(s)
Kts	knot(s)
KW	kilowatt(s)
IAMSAR	International Aeronautical and Marine Search and Rescue
ICAO	International Civil Aviation Organization
IMO	International Maritime Organization
m	metre(s)
MCTTD	Ministry of Communications, Transport and Tourism Development
MetService	New Zealand Meteorological Service
MHz	Mega Hertz
PIMLAR	Pacific Islands Maritime Legislation and Regulations
RKS	Republic of Kiribati Ship
RNZAF	Royal New Zealand Air Force
SAR	search and rescue
SOLAS	International Convention for the Safety of Life at Sea
SPC	Secretariat to the Pacific Islands Community
SSR	search and rescue region
STCW	International Convention on Standards of Training, Certification and Watchkeeping 1978 as amended
UNCLOS	United Nations Convention on Law of the Sea
USP	University of the South Pacific
UTC	co-ordinated universal time
VHF	very high frequency

Glossary

Beaufort scale	is a standard scale, running from force 0 for calm to force 12 hurricane and above for the description of wind speed. Each value represents a specific range and classification of wind speeds with accompanying descriptions of the effects on surface features. It was originally developed as a system for estimating wind strengths without the use of instruments. It was introduced in 1806 by Admiral Sir Francis Beaufort (1774-1857) of the British navy to describe wind effects on a fully rigged man-of-war frigate of the period, and it was later modified to include descriptions of effects on land features as well. It is currently still in use for this same purpose as well as to tie together various components of weather (wind strength, sea state, observable effects) into a unified picture.
Knot	one nautical mile per hour

Data Summary

Vessel Particulars:

Name:	*Uean Te Raoi II*
Type:	single outrigger canoe
Limits:	near coastal – Inter-island
Length:	14 m
Breadth:	1.75 m approx, 5.8 m approx. with outrigger attached
Built:	May 2009
Propulsion:	a single inboard 27.5 horsepower Vetus Marine diesel engine driving a single fixed-pitch propeller
Service speed:	7.5 knots
Owner/operator:	Catholic Parish of Maiana
Crew:	5 plus skipper
Date and time:	13 July 2009 at about 1200[1]
Location:	**Republic of Kiribati**
Persons on board:	crew: 6 passengers: 46
Injuries:	19 deceased (confirmed) 16 missing presumed deceased
Damage:	Total loss
Investigator-in-charge:	Captain Iain Hill

[1] Times in this report are Kiribati Standard Time (UTC + 12 hours) and are expressed in the 24-hour mode.

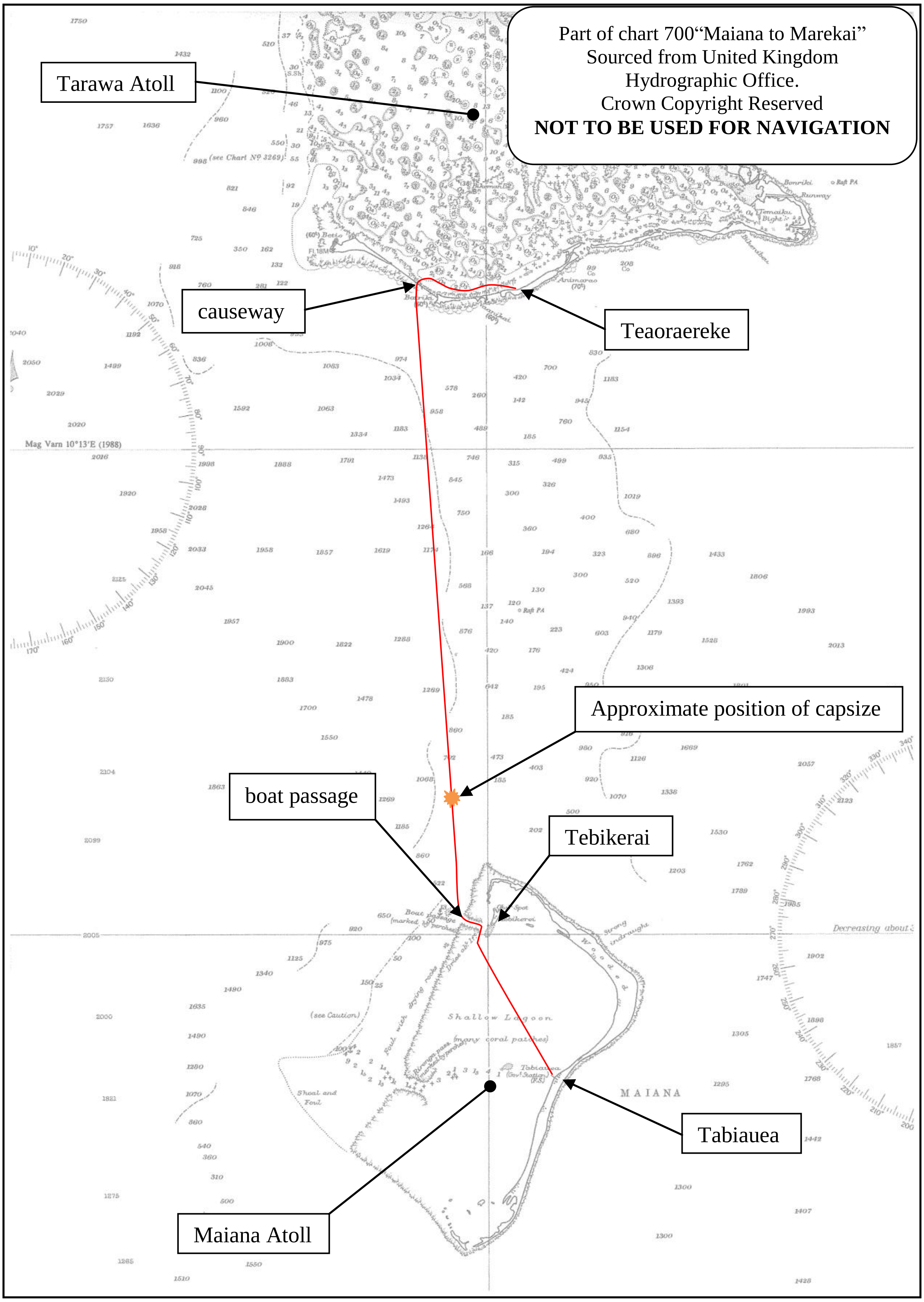


Figure 1
Chart of the general area Factual Information

1.1 Narrative

1.1.1 At about 1000 on Monday 13 July 2009, the vessel *Uean Te Raoi II* was scheduled to depart from the St. Iotebwa mwaneaba in the village of Teaoraereke for a voyage to the island of Maiana.

1.1.2 At about 0945, after loading what the "chief cargo" estimated to be about 1000 Kilograms (Kg) of cargo into the hold through the hatches in the deck of the vessel, the chief cargo of the *Uean Te Raoi II*, started calling the names that he had on his passenger list. He later said that there were 40 persons on his list. When he counted the passengers after the start of the voyage he counted what he thought was about 50 people in total but he was unsure where these other passengers had come from.

1.1.3 At about 1000, the *Uean Te Raoi II* departed from Maiana with the skipper, and 5 crew on board and what was later established as about 47 passengers. The skipper drove the vessel across the lagoon, then through the culvert under the causeway linking Bairiki and Betio Islands, out through the boat passage in the reef, and then headed south towards Maiana Island.

1.1.4 At about midday, when the vegetation on the island of Maiana was in sight but the beach could not be seen, one of the passengers who was sitting in one of the openings at the stern of the vessel with his legs over the side fell into the sea. Immediately the other passengers raised the alarm. The skipper of the boat manoeuvred the boat around and a line was thrown to the passenger in the water. When the boat had come to a stop the passenger was then recovered on board.

1.1.5 The skipper of the boat then turned the vessel back onto its original course increased to full service speed of about 8 knots and resumed the trip. A few minutes later as the boat entered an area of larger waves the pontoon on the outrigger started to rise up clear of the surface of the sea. This continued to occur again and again as the trip progressed with each elevation of the pontoon being greater than the last. This motion caused alarm amongst some of the passengers and also caused the passengers in the cabin to slide to the side away from the pontoon. During one of these events the *Uean Te Raoi II* rolled onto its starboard side, monentarily hung there and then capsized.

1.1.6 One of the crew of the boat later stated that:

> It took us about 10 minutes [to recover the passenger] after which the boat no longer sailed through the waves but rather gave its side where the outrigger was like sailed underneath the waves causing the outrigger to rise up. It felt like there was a change in the waves as they doubled and bigger and hitting the boat. I felt the rising up of the outrigger and some passengers too shouting that the outrigger is rising up. I was worried then and I went to the chief cargo and chief engineer who were outside the passengers lounge from the side where the outrigger was. I asked the chief cargo how was the outrigger and whether it would not capsize and the chief cargo responded to me and said that the boat had previously sailed many times like that and no accident ever happened … It was not long after I returned to my place at the back and the swaying continued and the rising too when the waves hit the boat when I suddenly found myself falling into the sea. I fell from the back side and the boat continued on but when I looked at it the outrigger was rising high and the boat sailed sideways and I heard screams from the passengers. It was about one or so minutes after I fell when the boat capsized.

1.1.7 At the time of the capsize one of the passengers estimated that the boat was about 6 to 7 miles from the village of Tebikerai on Maiana. Another passenger stated that they could see the village and tree tops of Tebikerai but could not see the shoreline.

1.1.8 The passengers and crew that were thrown clear of the boat when it capsized were able to assist other passengers to escape from the cabin of the upturned boat. The majority then clung to the upturned hull and pontoon. Some of the more fit and able of the crew and passengers swam under the boat and retrieved as many lifejackets as they could find from their stowage positions. These lifejackets were distributed amongst the passengers and crew.

1.1.9 Once the situation had stabilised 3 members of the crew and passengers elected to swim ashore to raise the alarm. These members were given lifejackets and all swam to the shore, and the first person to make it to shore took approximately 4 hours to swim the distance through the reef. He managed to stop a motorcyclist on the nearby road and was taken to the Police Post on Maiana.

The Rescue

1.1.10 The Police on Maiana immediately raised the alarm with their headquarters on Tarawa who followed their procedures for initiating a search for a missing vessel. Meanwhile the Priest of the Parish on Maiana was told of the accident and also initiated a search using some local vessels.

1.1.11 The Police on Tarawa contacted the Permanent Secretary for Communications, Transport and Tourism Development and also contacted the Marine Division. The Marine Division initially had difficulty contacting the Director of Marine as the Marine Guard did not have his mobile telephone number. The police headquarters realising that the patrol boat *RKS Teanoai* would be required started to gather crew and resources ready for an operation.

1.1.12 Once the Maritime Department had requested the use of the *RKS Teanoai*, the Police maritime unit needed to ensure that the vessel was adequately fuelled, stored and crewed. The head of the maritime unit said, after the accident, that under normal circumstances the time required to ready the vessel for operation was 4 hours or 2.5 hours in an emergency. As the accident happened during Kiribati independence celebrations difficulty was encountered in getting a crew assembled as the members of the maritime unit were dispersed throughout South Tarawa in their home villages. The first notification was received by the Police maritime unit at 1655 and the *RKS Teanoai* departed its berth in Betio at 2130.

1.1.13 At 0001 on 14 July 2009, the *RKS Teanoai* arrived at the position designated by the Director of Marine. The commanding officer of the *RKS Teanoai* then set up a search plan in the area illustrated in Figure 2. After completing this search pattern the Director of Marine provided a set of waypoints, via the Marine Guard, through which the next search was carried out. The Director of Marine then provided a further 2 sets of waypoints which were used for conducting searches.

1.1.14 Over the next 2½ days the *RKS Teanoai* searched between the positions supplied by the Director of Marine. At about 1240 on 16 July 2009 the ship was in position 00° 58'.0 N 171° 57'.0 E when it was advised that survivors had been sighted in position 01° 15'.0 N 173° 00'.0 E. The ship was about 68 nautical miles from the position of the survivors, so the commanding officer directed the ship to proceed at full speed to the survivors position. At about 1640 the *RKS Teanoai* sighted wreckage in the water in position 01° 13'.6 N 172° 52'.5 E, which was part of the *Uean Te Raoi II* with 2 yellow lifejackets about 100 yards [91.44 m] away. The *RKS Teanoai* spent the next 13 hours searching in the vicinity before returning to Betio without having found any more survivors.

1.1.15 On 15 July 2009, the New Zealand High Commission in Kiribati (NZHC) approached the pilot in command of a Royal New Zealand Air Force (RNZAF) Lockheed C130 Hercules transport aeroplane (C130) that was in Tarawa on a diplomatic mission to render assistance if possible. This request was also made by the diplomatic passenger of the C130, the New Zealand Minister for Foreign Affairs, to the head of the New Zealand Defence Force (NZDF).

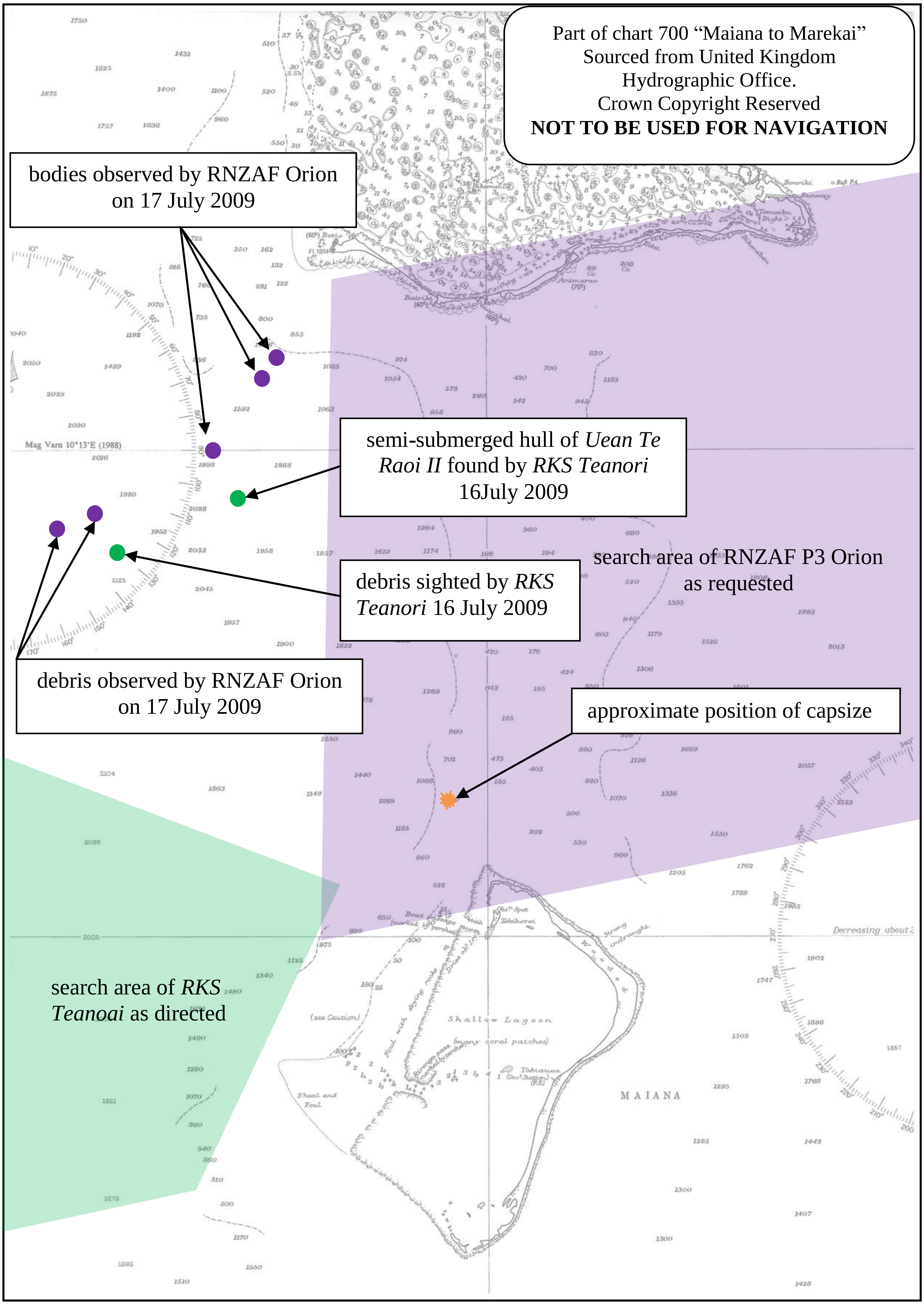


Figure 2
Search areas

1.1.16 On 15 July 2009 at about 2309, the head of the NZDF approved the search, and the pilot in command of the C130 contacted the New Zealand Rescue Coordination Centre (NZRCC) for help regarding search areas. The NZRCC advised that RCC Suva, in Fiji, would be the controlling agency for any Search and Rescue action as Kiribati fell into its search and rescue region. NZRCC could act as liaison if required but any request for assistance for RNZAF assets would need to come from RCC Suva. NZRCC then advised RCC Suva of the details of the accident. NZRCC used their computer software to develop a search area from the details that were provided by the pilot.

1.1.17 At about 0640 on 16 July 2009, RCCNZ contacted their counterparts in RCC Suva to find out if they were aware of the situation off Tarawa; RCC Suva confirmed that they were aware of the situation. RCCNZ informed RCC Suva that NZDF had approved the use of the aircraft, but RCCNZ required an official request from RCC Suva. About 2 hours later RCCNZ contacted RCC Suva and advised them that although RCCNZ had not received an official request from them RCCNZ had tasked a C130 aircraft to conduct a search of an area as determined by the RCCNZ computer modelling tool.

1.1.18 At about 0721, RCCNZ received a telephone call from the navigator on board the C130 aeroplane saying that the information received from Kiribati was that the survivors had drifted in a westerly direction, 180° different from that in the RCCNZ plot. RCCNZ explained that the ocean current drift was taken in real time from satellites and that RCCNZ was confident in their search area.

1.1.19 At about 0934, the RNZAF C130 aeroplane took off from Tarawa and commenced searching in the designated area. Due to operational constraints the C130 aeroplane was only able to spend about 2 hours on scene searching before departing.

1.1.20 At about 0948, RCCNZ received an email from RCC Suva thanking RCCNZ for its assistance.

1.1.21 At about 1220, RCCNZ received a telephone call from New Zealand Joint Forces (NZJF) advising it that a RNZAF Lockheed P3 Orion Maritime Patrol Aeroplane (P3) was in the area and maybe available for search duties if an official request was made. RCCNZ called RCC Suva and passed on the information and requested an update on the situation in Kiribati.

1.1.22 At about 1438, RCCNZ called RCC Suva, who immediately requested the use of the P3 aeroplane. RCCNZ requested that RCC Suva put the request in writing and email it to RCCNZ. At about 1500, RCCNZ received the email request from RCC Suva.

1.1.23 At about 1620, the P3 which was located in Vanuatu was tasked with search duties. The search duties were to commence on scene at about 1100 the following day, 17 July 2009. Throughout the following hours RCCNZ used its computer software to develop a search area determination (SAD) using available resources including weather information from MetService and other satellite information. At about 2210 RCCNZ requested RCC Honolulu for a search area determination comparison.

1.1.24 At about 0036, on 17 July 2009, RCCNZ received a SAD comparison from RCC Honolulu which supported the SAD plan generated by RCCNZ.

1.1.25 At about 0628, RCCNZ received a call from RCC Honolulu asking if any further assistance was required such as a C130 aeroplane for a search. RCCNZ explained that a P3 had been tasked with the search and would be on scene that morning.

1.1.26 On the morning of 17 July local fishermen located first survivors between the islands of Maiana and Tarawa, where the fishermen were fishing at the time.

1.1.27 At about 0742, the P3 aeroplane departed Vanuatu en-route to the search area. At about 0925 RCCNZ received a call from the New Zealand High Commission reporting that survivors and bodies had been found overnight and the position where they had been found. As this position was different from that detailed in the SAD, NZRCC contacted New Zealand Joint Forces and requested it to ignore the SAD sent previously and for the aeroplane to search between Maiana and Tarawa.

1.1.28 At about 1130, the P3 aeroplane arrived on scene and started searching. During the search the P3 aeroplane located debris outside of its search area when it was turning to make another pass over the search area. This debris was described as being located in an eddy line in the water. The crew subsequently moved their search area 2.5 nm to the north and started to identify further debris and bodies in the water until about 1758, when it departed the scene due to failing light and landed at Tarawa.

1.1.29 On 17 July at about 1815, the Director of Marine called off the search effort as it had been concluded that there were no more bodies to be found. The main hull of the *Uean Te Raoi II* was not recovered.

1.2 Climatic conditions

1.2.1 The weather was described by the survivors as being a wind from the north-east and with the sea and swell from the same general direction. The wind was estimated to be about Beaufort force 4, which was described as a moderate breeze with a speed about 11 to 16 knots causing numerous small waves, becoming longer with numerous whitecaps.

1.2.2 Witnesses reported that the boat had entered an area of increased sea conditions shortly before the capsize. The area was known for rougher seas caused by tidal eddies and overflows.

1.2.3 The New Zealand Meteorological Service (MetService) provided an after-cast of the weather at the time of the incident. The full details of the after-cast are contained in Appendix 1. The after-cast summary stated:

> Assessment of weather and wave conditions between Maiana and Tarawa between 12 and 16 July 2009
>
> The satellite observations of the wind over the ocean near Tarawa are fairly consistent with the observations made at Bairiki. Through this period the wind was from the easterly quarter about 10 knots. There was a short period of stronger wind of about 20 knots from the southeast between about 1200 UTC 14 July and 0300 15 July 2009.
> Sea conditions through this period would be described as “smooth” to “slight” in the Beaufort sea scale. The range of significant wave heights was probably 0.6 to 1 metre and occasional waves of 1 to 1.5 metres. During the period of stronger wind between 1200 UTC 14 July and 0300 15 July, the sea would have risen and would be described as “moderate” in the Beaufort scale by about 0000 UTC 15 July, and the significant wave height probably rose to about 2 metres with occasional waves about 2.5 metres around 0000 UTC.
> Tidal currents across the relatively shallow ocean between Tarawa and Maiana would have increased wave heights when the tidal flow was in the opposite direction to the wind. (New Zealand Meteorological Service (MetService), 2009)

1.2.4 The acting director of the Meteorological Division of the Republic of Kiribati Government was interviewed after the accident and he confirmed that the division received the 2 daily forecasts from the Fijian Meteorological Service. He also said that these weather forecasts were re-distributed to the local radio station for broadcast. The Meteorological Division did not supply specific marine forecasts unless requested. These requests were usually received from foreign yachts visiting the Republic of Kiribati. The acting director also said that it was very rare to be asked by local industry or the Marine Division for a marine forecast. The acting director said that the Marine Division had not requested any weather data from Meteorological Division during the search and rescue operation.

1.3 Personnel information

1.3.1 The skipper of the boat was not the skipper who was usually in charge of the boat, but the usual skipper's 27-year-old son. This younger skipper was a national of the Republic of Kiribati and did not survive the accident.

1.3.2 What experience that the younger skipper had was unknown, but he was thought to have accompanied his father on numerous occasions and to have had a basic understanding of the working of the vessel.

1.3.3 No evidence could be found that the skipper had a nautical qualification suitable for being skipper of the *Uean Te Raoi II*. The University of the South Pacific (USP) in Tarawa confirmed that he had been attending a part-time course to obtain a Master Class Six certificate of competency which was required for being skipper of the boat. He had not, however, completed the course and had not sat the Director of Maritime's required oral examination.

1.4 Vessel information

1.4.1 The *Uean Te Raoi II*, was a single outrigger design canoe with a single skin construction from sheeted marine ply. It was built by a master boat-builder on Abatao, one of the islands of the Tarawa Atoll, to an elongated "Kiribati 5" design produced by a Norwegian naval architect.

1.4.2 The boat was powered by a single inboard 27.5 horsepower [20.51 KW] Vetus Marine diesel engine which gave an operating speed of about 7.5 knots

1.4.3 The *Uean Te Raoi II* was owned and operated by the Catholic Parish of Maiana. The priest from the parish had contacted the boat-builder and arranged for the boat to be built in stages, as and when funds were available from the parish. The boat-builder estimated that the total cost of the boat and the fittings that he agreed to supply would be about 65,000 Australian dollars. The Parish of Maiana made an initial payment of $10 000 during February 2008 so that work could commence.

1.4.4 The boat was launched on 27 May 2009. At this time 7 payments totalling $53,500 had been made by the parish, and a further payment of $1,000 was made prior to the boat-builder handing over the boat to the Parish.

1.4.5 The priest from the parish was, on behalf of the committee in charge of the boat, responsible for obtaining the registration of the boat, the seaworthiness certificate and the licence to trade.

1.4.6 On 2 June 2009, the priest attended the Marine Division office and paid $1050 in fees for the boat to be inspected and the appropriate certificates issued. At this time he was aided by the marine surveyor in filling out the required forms. The marine surveyor stated that he had a long discussion with the priest about the requirements for the boat. The priest also requested that the inspection of the boat be carried out on 6 June 2009 at the same time as the launching ceremony.

1.4.7 On 6 June 2009, the marine surveyor inspected the boat while celebrations were being held on Tarawa for the delivery of the *Uean Te Raoi II* and the finding of a suitably qualified skipper to command the boat. The marine surveyor did not issue a certificate of seaworthiness for the vessel at this time as the electronic position indicating radio beacon (EPIRB) was not available. The EPIRB had been ordered and was due to arrive in August 2009, after which the surveyor intended to complete his inspection.

1.4.8 The priest of the parish requested that the *Uean Te Raoi II* be allowed to complete a single voyage to Maiana on 7 June 2009, to attend a celebration prepared by the Catholic Parish of Maiana. The marine surveyor agreed to this once-only voyage.

1.4.9 At the time of the accident the *Uean Te Raoi II* was on its twelfth commercial trip between the islands of Tarawa and Maiana.

Concept of outrigger vessels

1.4.10 Outrigger vessels have a main hull of slender proportions and usually this will have only marginal stability if it is not externally supported. The support is provided by a smaller outrigger hull, usually on the port[2] side. This design was originally developed because it was made from available timber (tree trunks), and it provided a low drag hull form which was suitable for the modest propulsion powers of paddling or wind.

1.4.11 With regard to stability, when the vessel tends to roll to port, the outrigger is forced further into the water and the increasing buoyancy force on the outrigger will then roll the vessel back to upright (see Figure 3).

1.4.12 The net weight of the outrigger, as perceived from the main hull via the cross beams, is its total weight minus the buoyancy forces. When the vessel rolls to starboard, the outrigger lifts and the buoyancy forces decrease. There is therefore an increase in the net outrigger weight, and this acts to bring the main hull back to the upright position (see Figure 3).

1.4.13 In extreme events the outrigger will be either forced completely under, or will lift completely out of the water. After either of these events there can be no useful increase in the righting forces provided by the outrigger. Once it is airborne its apparent weight can no longer increase, and the righting lever arm will decrease as the vessel rolls further bringing the outrigger horizontally closer to the main hull. For the *Uean Te Raoi II*, the outrigger would become airborne at a roll angle of about 5°.

1.4.14 The stability of outriggers is a combination of the righting moment provided by the outrigger, plus the stability inherent in the main hull. After the outrigger is airborne during a roll to starboard, it is only the small reserves of stability available from the main hull that are preventing a complete capsize.

1.4.15 The following factors combined or in isolation apply a capsizing moment to a vessel:

- wind
- shifting of load
- wave action
- roll momentum.

1.4.16 Winds acting from angles near the beam will cause forces that tend to heel the vessel and, particularly for sailing vessels, these may lead to capsize. It is generally preferred to operate outrigger vessels with the outrigger to windward. The reason for this is to prevent a sudden loss of control if the outrigger to leeward is forced under. The risk of having the outrigger to windward, and possibly airborne, is considered more manageable. This option is not always available when a vessel is motor-driven and providing a service on a specific route.

1.4.17 With the outrigger to windward it is not unusual to add extra ballast such as sandbags or persons on the outrigger or cross beams to improve stability. Verbal reports received indicated that on similar vessels in Kiribati the weight of both passengers and crew had been used at times on the area decked across the forward cross beams. This practice was reviewed after a structural failure of the cross beams on a different vessel, and on the *Uean Te Raoi II* only crew were permitted to be used as ballast weight.

1.4.18 An independent naval architect was employed to provide an overview of the stability of the *Uean Te Raoi II*, the full details of which are contained in Appendix 2. He noted in his report that the vessel *Uean Te Raoi II* was loosely based on the proven KIR-5A design, but with some significant variations. Most dimensions were increased by about 25%, which resulted in a vessel of almost twice the volume of the original design.

[2] For reasons to do with right-handedness of the original paddlers.

1.4.19 He also noted that the layout of the vessel was changed, with the addition of a cabin structure that caused more wind resistance, and with the passengers being carried on top of the hull instead of lower inside the hull with the original design. These factors contributed to a decrease in the vessel's safety, with regard to its resistance to capsize.

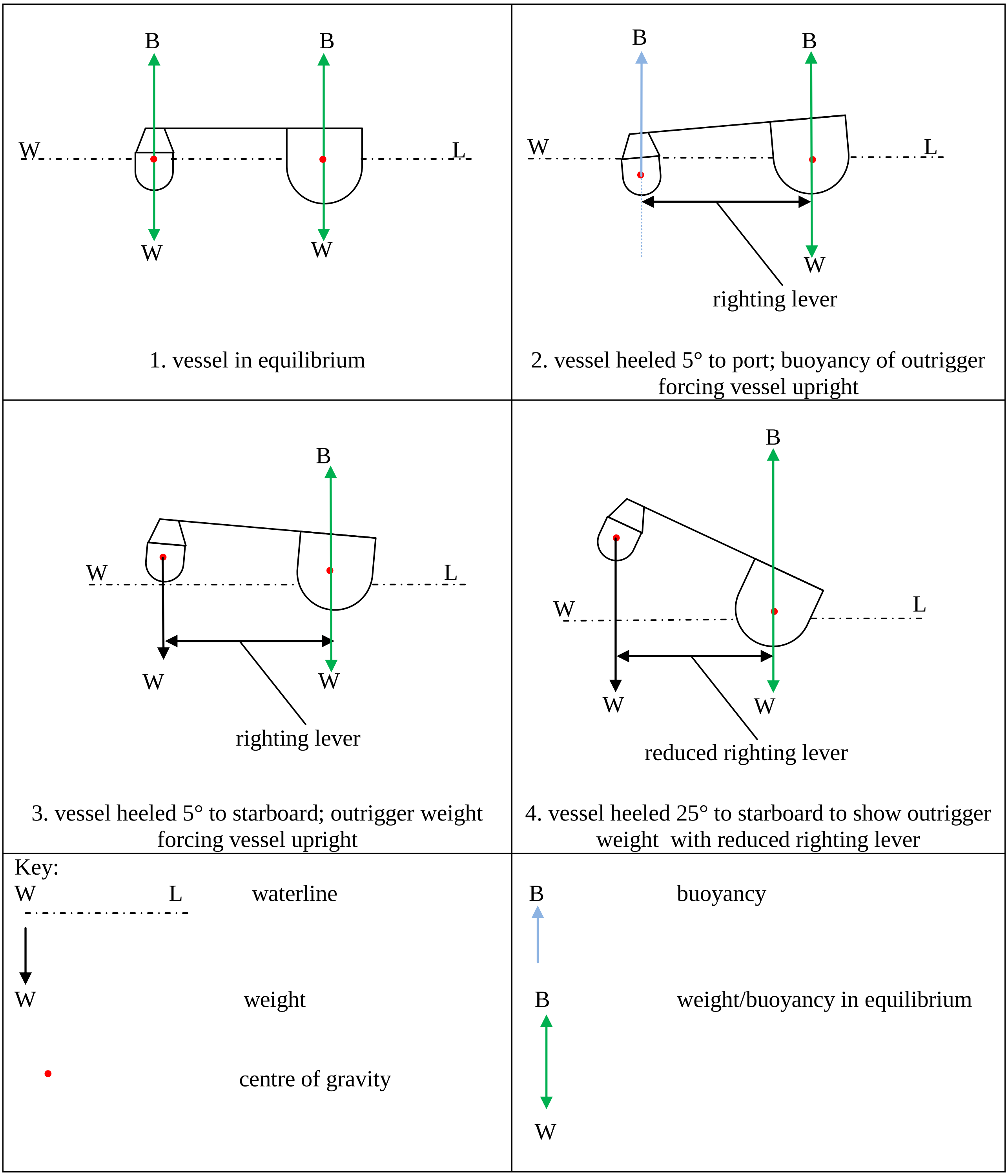


Figure 3
Diagram showing effect of outrigger on stability of the vessel

1.4.20 He said that an earlier decision not to allow weight to be carried on the cross beams addressed a structural issue, but prevented the traditional method of stability improvement used on this type of vessel (Stronach & Associates, 2009).

1.5 Regulatory aspects

1.5.1 The Republic of Kiribati has 2 Acts which control and impact on shipping; the Merchant Shipping Act 1983 as amended; and the Shipping Act 1990 as amended. (Government of the Republic of Kiribati, 2009).

1.5.2 The primary purpose of the Merchant Shipping Act 1983 was to provide for a shipping registry. A 2006 amendment broadened this to an open registry, as well as incorporating IMO conventions into Kiribati law. Section 2B of the Merchant Shipping Act, for example, stated:

> **Application of International Conventions**
>
> The international conventions set forth in the second schedule, and any amendments thereto, (unless an amendment has been objected to by Kiribati), shall have the force of law in Kiribati, subject to any reservation as Kiribati may make at the time of accession. From and after the date that the convention enters into force for Kiribati following the deposit of the instrument of accession with the relevant depositary.

The second schedule included the following conventions:

- United Nations law of the sea – acceded February 2003
- International convention on the control of harmful anti-fouling systems on ships, 2001 – acceded 17 September 2008
- International convention for the control and management of ships' ballast water and sediments, 2004 – acceded 5 February 2007 (note this convention is not yet entered into force internationally)
- International convention on civil liability for bunker oil pollution damage, 2001 – deposit of instrument 29 July 2009 entry into force date 29 October 2009
- Protocol of 1992 to amend the international convention on civil liability for oil pollution damage, l969 – acceded 5 February 2008
- Convention on the international regulations for preventing collisions at sea, 1972 – acceded 5 February 2007
- Protocol of 1992 to amend the international convention on the establishment of an international fund for compensation for oil pollution damage, 1971 – acceded 5 February 2008
- Convention on limitation of liability for maritime claims, 1976 – acceded 5 May 2007
- International convention on load lines, 1966 – acceded 5 may 2007
- Protocol of 1988 relating to the international convention on load lines, 1966, - acceded 5 May 2007
- Convention on the prevention of marine pollution by dumping of wastes and other matter, 1972, - acceded 12 July 1979
- Protocol of 1978 relating to the international convention for the prevention of pollution from ships, 1973 – acceded 5 May 2007 (annexes i to v)
- Protocol of 1997 to amend the international convention for the prevention of pollution from ships, 1973, as modified by the protocol of 1978 (annex vi) – acceded 5 May 2007
- International convention on salvage, 1989 – acceded 5 February 2008
- International convention on maritime search and rescue, 1979, - acceded 7 March 2007
- Torremolinos protocol of 1993 relating to the Torremolinos international convention for the safety of fishing vessels, 1977 – acceded 5 February 2007 (note this convention is not yet entered into force internationally)
- International convention for the safety of life at sea, 1974 – acceded 5 may 2007
- Protocol of 1978 relating to the international convention for the safety of life at sea, 1974 – acceded 5 May 2007
- Protocol of 1988 relating to the international convention for the safety of life at sea, 1974 – acceded 5 May 2007

- International convention on standards of training, certification and watch keeping for seafarers, 1978 (STCW), - acceded 5 November 1987
- International convention on standards of training, certification and watch keeping for fishing vessel personnel, 1995 – acceded 5 February 2007 (note this convention is not yet entered into force internationally)
- Convention for the suppression of unlawful acts against the safety of maritime navigation – acceded 16 February 2006
- Protocol for the suppression of unlawful acts against the safety of fixed platforms located on the continental shelf – acceded 16 February 2006
- International convention on tonnage measurement of ships, l969 – acceded 5 May 2007.

1.5.3 The primary purpose of the Shipping Act 1990 was to enable accession to the STCW convention and to introduce some controls around domestic ships and foreign ships operating on the coast of the Republic of Kiribati. The following definitions within the Shipping Act are relevant to this inquiry:

- "vessel" means every description of craft used or capable of being used in marine transportation and includes a fishing vessel, or hovercraft, a non displacement vessel and a mobile offshore unit, but does not include –
  - a seaplane and a vessel under construction but not yet launched;
  - a vessel belonging to the defense force of any country;
  - a vessel employed in navigation on a lagoon, lake, river or an inland water;
  - the life boat, raft, work boat or a launch which forms part of the equipment of a larger vessel and is being used as such; and
  - a punt, barge or other workboat whose sole means of propulsion is by manpower or towing
- "near coastal voyage" means a voyage or trade or an operation of a vessel of any island in Kiribati within 200 nautical miles off the coast, or a voyage, trade or an operation of a vessel within or between the Gilbert group of islands, the Phoenix group of islands the Line groups of islands and Banaba that comprise the Republic of Kiribati
- "passenger" means any person carried on board a vessel with the knowledge or consent of the owner or master of the vessel but does not include -
  - a person engaged in any capacity on board the vessel in the business of the vessel; or
  - a child under the age of 1 year.

1.5.4 Section 11(1) of the Shipping Act required that:

> "No vessel whatever its means of propulsion, shall proceed upon any voyage or excursion unless such vessel has a certificate of seaworthiness issued under section 10 or by other competent authority, valid and unexpired, which must be produced together with the certificates of competency of the officers and engineer required for the voyage to a customs officer before any clearance can be obtained or on demand by any lawfully appointed officer."

Section 19(1) required that:

> "Without prejudice to section 18, no vessel shall engage in a Near-coastal voyage unless there is in force at that time a licence in the form which may be prescribed granted in respect of that vessel by the Director of Marine under this section and such fee as may be prescribed for such licence has been paid."

Section 16 allowed the Minister to make regulations under this Act and to prescribe penalties for the breach thereof in regard to:

- all such matters as may be prescribed;
- the qualifications of applicants for certificates of competency;
- the standards for seaworthiness, equipment and machinery of all vessels engaged in trade or passenger traffic;
- the requirements as regards safety at sea equipment;
- the lights to be shown, signals to be used, and the sailing rules to be observed;
- the marking, naming or numbering of vessels; and
- generally for giving effect to, and carrying out the provisions of, this Act, the Convention and the Code and for their due administration.

To date the Minister had not made any regulations, for the control of these matters.

1.6 Search and rescue

1.6.1 On 22 June 1985, the International Convention on Maritime Search and Rescue, 1979 (International Maritime Organization, 1979) came into force; the convention was amended in 1998 and again in 2004. The Republic of Kiribati acceded to this convention on 7 March 2007. This convention was:

> … aimed at developing an international search and rescue plan, so that, no matter where an accident occurred, the rescue of persons in distress at sea will be co-ordinated by a search and rescue organization and, when necessary, by co-operation between neighbouring search and rescue organizations …
>
> The technical requirements of the search and rescue Convention were contained in an annex [to the convention], which was divided into five chapters. Parties to the Convention were required to ensure that arrangements are made for the provision of adequate search and rescue services in their coastal waters.
>
> Parties were encouraged to enter into search and rescue agreements with neighbouring states involving the establishment of search and rescue regions, the pooling of facilities, establishment of common procedures, training and liaison visits. The convention states that parties should take measures to expedite entry into its territorial waters of rescue units from other parties. (International Maritime Organization, 1979)

1.6.2 The Republic of Kiribati acceded to the United Nations Convention on the Law of the Sea (UNCLOS) on 24 February 2003. Part V, Article 55 of the Convention states:

> Specific legal regime of the Exclusive Economic Zone
>
> The Exclusive Economic Zone is an area beyond and adjacent to the territorial sea, subject to the specific legal regime established in this Part, under which the rights and jurisdiction of the coastal State and the rights and freedoms of other States are governed by the relevant provisions of this Convention. (United Nations, 2009)

A state's Exclusive Economic Zone (EEZ) extends out 200 nautical miles from the states baseline, except where 2 or more states' EEZ overlaps and then it is up to the states concerned to come to an agreement.

1.6.3 Figure 4 graphically shows the republic of Kiribati's EEZ superimposed on a chart of some of the Pacific's Search and Rescue (SAR) regions. Due to the geography of the Republic of Kiribati, the islands being spread across a swathe of the equatorial Pacific Ocean, the islands and their contiguous EEZ fall into 5 different SAR regions.

1.6.4 Under UNCLOS "Parties to the Convention were required to ensure that arrangements are made for the provision of adequate search and rescue services in their coastal waters." The Republic of Kiribati used its single patrol vessel the *RKS Teanoai*, for this purpose supplemented by other private local craft.

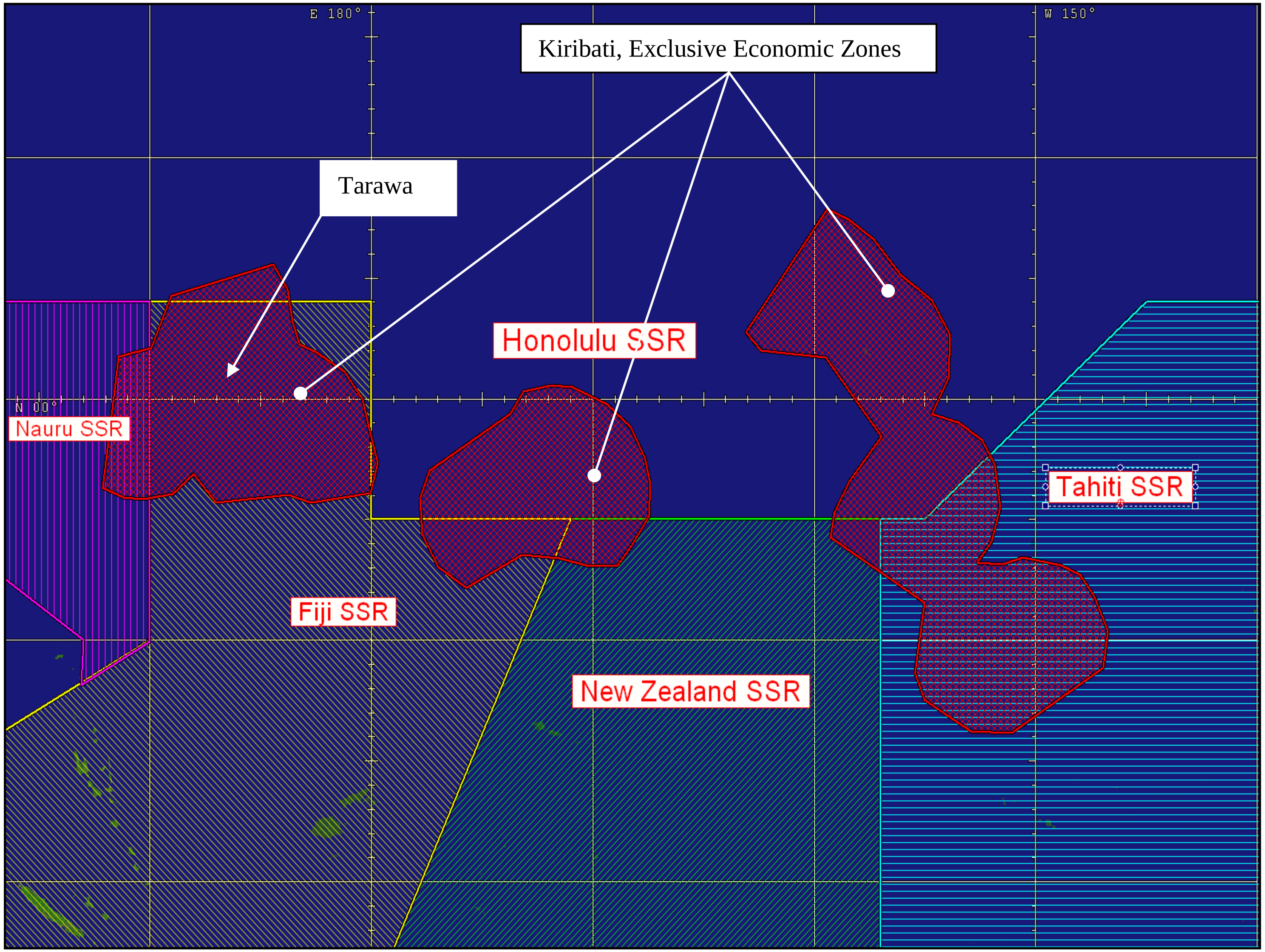


Figure 4
South Pacific search and rescue regions

1.6.5 In 1998, the International Maritime Organization (IMO) in conjunction with the International Civil Aviation Organization (ICAO) produced the International Aeronautical and Marine Search and Rescue (IAMSAR) Manual the primary purpose of which:

> … is to assist States in meeting their own search and rescue (SAR) needs, and the obligations they accepted under the Convention on International Civil Aviation, the International Convention on Maritime Search and Rescue and the International Convention for the Safety of Life at Sea (SOLAS). These volumes provide guidelines for a common aviation and maritime approach to organizing and providing SAR services. States are encouraged to develop and improve their SAR services, co-operate with neighbouring States and to consider their SAR services to be part of a global system. (IMO & ICAO, 2007)

Volume 3 of this manual was for mobile facilities and was intended to be carried aboard aircraft and vessels to help with performance of a search, rescue, or for use by the on-scene coordinator to aid with aspects of SAR. The manual contained examples of differing search methods and other pertinent information on the search for survivors from accidents.

1.6.6 In the Republic of Kiribati the responsibility for search and rescue co-ordination was invested in the Marine Division. For a search and rescue operation to be undertaken the Director of Marine was required to sign an authorisation. If the Marine Division required the use of a vessel the Marine Division could request the use of the Police department's patrol vessel *RKS Teanoai*. The Police department's maritime unit would then respond to the Marine Division's request and would be directed by the Director of Marine on where to search.

1.6.7 The Marine Division worked to a high-level quality manual (Government of Kiribati, 2007) in which Part B, Working Practices and Procedures, section 2.15 Search and Rescue, stated:

> **Mission Coordinator**
>
> - Acknowledge distress, or urgency message
> - Plot search area and develop a feasibility plan and identify all available SAR assets
> - Brief all SAR crew and deploy available aircraft for air search or available vessel for surface search.
> - Coordinate with all rescue coordinating centres
> - Establish and maintain full 24 hour communications with On Scene Commander
> - Liaise with all domestic shipping and fishing companies for possible support to the operation
> - When successful, call off rescue operation and cease broadcasting distress on radio.
> - If SAR operation not successful, call off operation but maintain sending distress message on radio. Request Fisheries Licensing Unit to notify all licensed fishing vessels in the proximity of the distressed vessel to assist if and when sighted.
> - Debrief all SAR crew.

1.6.8 The Marine Division did not have a search and rescue plan for vessels in Kiribati coastal waters and did not have a formal agreement with any other country with respect to search and rescue. However, the Marine Division had an informal agreement with Fiji that if an EPIRB was detected in Kiribati coastal waters, Fiji would advise Kiribati of the location, Kiribati would then instigate a local search, but could ask for assistance if they were unsuccessful in locating the EPIRB. In this case the Marine Division did not advise the Rescue Coordination Centre Suva (RCC Suva) of the situation and did not request assistance.

1.6.9 The head of the Police's maritime unit, an assistant chief superintendent, had received training on search and rescue in the United States of America and also in Australia. He was conversant with the different search methods and patterns and with the use of the *RKS Teanoai*.

1.7 Marine division

1.7.1 The Marine Division had 3 technical positions; the Director of Marine, the Principal Surveyor and a Marine Officer. The position of Marine Officer was vacant and the Director of Marine had recently retired and was on a retainer until a replacement could be found.

1.7.2 The Kiribati open registry was run under contract by a company in Singapore entitled the Kiribati Ship Registry. However, under the Merchant Shipping Act the Director of Marine was still the Registrar of Ships. Little evidence could be found of control of the Kiribati Ship Registry by the Director of Marine and he had little understanding of his responsibility as the Registrar or the obligations placed on Kiribati by the international marine conventions.

1.7.3 The Marine Division worked to a high-level quality manual (ibid). Clause 2.4, ensuring all domestic legislation and regulations are met, allowed for the following:

- The Director of Marine is the regulatory authority and maintains policing of the local berths to ensure that shipowners, ship operators and ship charterers comply with regulations and ship masters do not overload their ship or carry excessive passengers. Overloaded ships are detained and prevented from leaving until the ship is up to her marks. Ships carrying excessive passengers are detained until the certified number, as specified in the ship's trading license, remain. The Director of Marine has the option under his discretion to either prosecute a ship master who overloads his ship or carry excessive passengers, or revoke the ship's trading licence.
- The Director of Marine shall advise the Secretary of any deficiencies in marine legislation and submit a proposal for any amendments. The Secretary shall seek the advice of the Attorney General on the proposal made by the Director of Marine. The Attorney General shall provide comments, if any, to the proposal. The Secretary provides an information paper on the final draft of the amendment to Cabinet. Cabinet considers and approves the amendment for;
  - 2.5.1 in the case of any Act, for approval by Parliament
  - 2.5.2 in the case of any regulation, for signature by the Minister (MCTTD) and the Secretary to Cabinet
- The Minister shall appoint the date of entry into force of any Act or Regulations
- All and any new or updated Legislation, Rules or Regulations will be included into this system as they are promulgated and made available to all masters, officers and engineer officers, radio officers and all other crew on board ships including Marine Division staff.

1.7.4 Under the quality manual surveyors were required to undertake surveys of non-convention vessels in accordance with the "Voluntary Survey Instructions and Guidelines for Pacific Islands Region" provided by the Secretariat to the Pacific Islands Community (SPC). The guidelines to surveyors were produced to complement Pacific Islands Maritime Legislation and Regulations (PIMLAR) in enforcing a set standard of efficiency for surveyors in Pacific Island countries. They were intended to unify and harmonise the level of safety within the Pacific Island country fleets of vessels (non-convention) thus creating safer travelling conditions. A copy of these guidelines could not be sourced in Kiribati at the time of the inquiry, but were later provided by the SPC.

1.7.5 The Marine Division generally required small interisland passenger/cargo ships to carry lifejackets for all persons on-board, a VHF or CB radio, an EPRIB and a compass. It was unclear though how it determined the load-carrying capacity of a vessel or the performance standard of the equipment required. For example, the total safe payload for the *Uean Te Raoi II* and the corresponding maximum number of passengers and crew for the vessel were estimated by the boat-builder, and these figures were used by the surveyor when making his first inspection. The boat-builder supplied the lifejackets but there was no standard of lifejacket stipulated; full SOLAS type lifejacket or a coastal personal flotation device type for example. There was no requirement for children's lifejackets to be carried, or for the number of passenger carried to be reduced commensurate with the amount of cargo carried.

1.8 International Maritime Organization (IMO) technical cooperation

1.8.1 In 1995, the IMO developed model legislation for Asian non-convention sized vessels. This model legislation was developed for ships over 15 m in length, but excluded fishing vessels and craft of primitive build.

1.8.2 At present the IMO is undertaking a project to further this initial model legislation and make it more applicable for other administrations. The IMO reported progress to the 17th session of the Flag State Implementation sub-committee in April 2009 as follows:

> NON-CONVENTION SHIPS
>
> 3.12 Having recalled that FSI 16 had requested the Secretariat to continue informing the Sub-Committee at future sessions on any update regarding activities implemented with regard to non-Convention ships, the Sub-Committee noted the updated information on the harmonization of activities of the Secretariat related to safety regulations for non-Convention ships on the basis of the thematic priorities for inclusion in the ITCP covering the 2010-2011 biennium which includes, as paragraph 7, promoting and enhancing maritime safety aspects relating to non-Convention vessels, including small fishing vessels and domestic passenger ferries.
>
> 3.13 In this context, the Secretariat is developing a single generic and common modular set of standards of harmonized regulations and model national legislation for ships not covered by the 1974 SOLAS Convention, as amended, and a model course for the training of the inspectors who are responsible for the survey of those ships in order to assist developing countries to enhance their capacity to strengthen their implementation of national safety regulatory measures for non-SOLAS ships.
>
> 3.14 The main part of task 1, i.e. the development of a set of regulations, has been completed, and is under revision for approval. The scope of the set includes, but is not limited to, new cargo ships engaged in inland waterways and maritime navigation, whose length overall is 12 metres or over and for which the provisions of the 1974 SOLAS Convention do not apply, as well as passenger ships carrying less than 200 passengers whose length overall is less than 24 metres and also fishing vessels.
>
> 3.15 The set of regulations takes into account existing model regulations for non-Convention ships developed by IMO for different regions as well as all available IMO documents on safety regulations for ships not covered by IMO Conventions; security, environmental and safety drives development and includes all necessary topics not included in the existing model regulations for non-Convention ships. The outcome provides two model courses (basic and advanced) advising participants on suitable policies relating to the implementation of the set of regulations. Both courses will be tested in regional courses after approval.
>
> 3.16 The Sub-Committee requested the Secretariat to continue providing updated information on activities implemented with regard to non-Convention ships and, in particular, the availability of training material for the inspection of such ships, which may be considered at some stage in the context of IMO Model Courses.

1.9 Voluntary IMO member state audit scheme

1.9.1 The Voluntary IMO member state audit scheme is intended to provide an audited member state with a comprehensive and objective assessment of how effectively it administers and implements those mandatory IMO instruments that are covered by the scheme.

1.9.2 It is expected that the audit scheme will bring about many benefits, such as identifying where capacity-building activities (for example, the provision of technical assistance by IMO to Member States) would have the greatest effect. Targeting of appropriate action to improve performance would be greatly improved. The Member States themselves receive valuable feedback, intended to assist them in improving their own capacity to put the applicable instruments into practice; and generic lessons learnt from audits are provided to all Member States so that the benefits could be widely shared

1.10 Torres Strait - A case study with similarities to the Kiribati environment

1.10.1 Information on the extent of maritime activity throughout the Kiribati group was not easy to come by because no formal statistics are kept. This was partly because of the broad requirements of the Shipping Act and the poor enforcement of what little regulations existed. The Director of Marine estimated there were about 10 ships operating domestically providing interisland services. These ships ranged from 100 to 1000 gross registered tonnes (GRT). Additionally there were a number of smaller "traditionally built" interisland ferries; possibly about 6 but this figure could not be confirmed. There are a significant number of smaller craft used to travel across the lagoons to outer islands within the same atoll, but again, these numbers were not recorded and proved difficult to establish. Until the scope of maritime activity can be established it will be difficulty to form a view on the extent of any problem identified within the maritime system.

Torres-Strait

1.10.2 Queensland Transport in conjunction with the Australian Maritime Safety Authority (AMSA) has provided assistance to the Maritime Authority of Papua New Guinea with the objective to save lives and reduce the number of lost seafarers by sustainably improving maritime safety in the Torres Strait[3].

1.10.3 The Torres Strait stretches 150 kilometres from the tip of Cape York Peninsula in North Queensland to the south-west coast of Papua New Guinea. Islands, reefs, and coral and sand cays are scattered throughout the region, the northern-most island reaching to within five kilometres of the Papua New Guinea coastline. The region includes 18 island communities, with populations ranging from 55 to 1631, and also two mainland communities. The islands are scattered over a geographic area of 48000 square kilometres. The region's total population is 8306, of whom 6168 are Torres Strait Islander and Aboriginal people.

1.10.4 Being island communities, much of the activity in the Torres Strait is water based and includes fishing, including commercial fishing, and traditional hunting for dugong and turtle. Furthermore travel between islands is undertaken in open dinghies for social, education, health and cultural activities.

1.10.5 The Torres Strait is a complex area to navigate safely. In addition to many reefs, islands and rocks the waters are subject to significant tidal flows, as well as steady, strong winds and choppy seas.

1.10.6 There are approximately 700 recreational boats in the region used by communities for a range of purposes including fishing, inter-island travel and hunting.

[3] Torres Strait Marine Safety Strategy, Australian Maritime Safety Authority and Maritime Safety Queensland

1.10.7 There are approximately 50 commercially registered vessels operating in the Torres Strait engaged in a range of activities including fishing for crayfish, passenger ferry operations, pilot transfer and carriage of cargo.

1.10.8 Seafarers in the Torres Strait face many risks arising from difficult sea states, poor access to engine maintenance, limited alternative to travel by sea and limited navigational equipment.

1.10.9 A programme was introduced to save lives by reducing the numbers of lost seafarers, increasing the survival of lost seafarers, and increasing community and industry commitment to safety through partnerships with communities, industry and government agencies.

1.10.10 Fundamentally the programme has concentrated on the three elements; training, education and building relationships. Extensive consultation was conducted with communities first and training was the most important area they identified. The main causes of occurrences were identified as breakdown of motors from contaminated fuel, poor or no engine maintenance, running out of fuel, poor weather, and overloading.

1.10.11 The three elements all worked towards building a safety culture among individuals and communities. The themes used were "Come home safely to your family" and "stop, think and survive before you head out". Families are very important and the loss of a family member does have long lasting effects on the community.

1.10.12 The training was concentrated on delivering recreational licensing into communities through the Australian recreational training scheme called Boatsafe. Queensland Transport modified the content to suit the area, including literacy levels. The issues covered were not so much how to drive a boat, because most knew how to do that well, but more on planning a trip, ensuring the boat is seaworthy, carrying enough fuel and the use of safety equipment.

1.10.13 An integrated safety education campaign has run in support of Boatsafe promoting safety messages to the communities. This has included television commercials filmed locally, and press and radio advertising. Map stickers were distributed that promoted how much fuel was needed to reach different locations; a pocket handbook that covered emergency procedures and what safety equipment is needed. An outboard maintenance pocket-sized handbook is still being developed.

1.10.14 An evaluation of the program made in 2008 showed promising results. Initiatives appeared to be working and the communities are taking more notice, families are getting more involved, especially womenfolk, and a safety culture is beginning to emerge.

1.10.15 Another initiative was an EPIRB exchange program funded co-jointly with AMSA. With the introduction of the 406 MHz EPIRB there was great concern that many operators would fail to understand why the 121.5 MHz EPIRB would cease to operate and then not upgrade due to cost.

1.10.16 EPIRBs have significantly reduced costs of search-and-rescue over the years simply through being able to locate boats within a number of hours instead of days, which has resulted in an increased survival rate.

2 Analysis

Uean Te Raoi II

2.1 The design and construction of the single outrigger canoe type of vessel such as the *Uean Te Raoi II* was suited to the area of operation for several reasons. The main hull had a shallow draft and was streamlined for efficiency in fuel consumption. The use of marine ply for construction has the advantage that it is comparatively cost effective and readily accessible. It is also easier to effect temporary repairs if damaged while in the outer islands, compared to a hull constructed in glass-reinforced plastic for example. In any event the construction of the vessel was not in question in this accident. The methods and quality of build was observed to have been to a high standard, and from witness accounts the structure of the boat withstood capsize and subsequent pounding from moderate seas, both inverted, and upright but semi-submerged, for a number of days before sinking.

2.2 The stability concept for single outrigger canoes such as the *Uean Te Raoi II* differs from standard type of single or catamaran style hulls. A catamaran style hull will generally be more stable than the single outrigger style, but is much more costly to build. The reason for not building a second outrigger on the other side was again cost, but more importantly for vessels operating out of South Tarawa, they could not fit through the narrow culvert under the causeway linking the islands of Bairiki and Betio. Vessels that could not fit under the causeway would need to travel a further 12 nautical miles on a journey from the village of Teaoraereke to Maiana Island, adding about 1.5 hours to the journey for a vessel travelling at the speed of *Uean Te Raoi II*.

2.3 The independent naval architect noted in his report (see Appendix 2) that the design of the *Uean Te Raoi II* was based on a proven modernised version of a traditional outrigger canoe, the *KIR-5A*. However, the *Uean Te Raoi II* differed in design from the original in several significant ways.

- the overall size of the hull had been increased by about 25 per cent (%) on average resulting in a lightship displacement that is approximately twice that of the *KIR-5A*
- the outrigger had, however, only been increased in length by about 12%
- the outrigger offset had been increased by about 29%
- the main hull had been decked over, requiring the passengers to sit on top of the hull as opposed to in the hull as in the *KIR-5A* design, which effectively raised the centre of gravity of the whole boat when loaded with passengers
- a cabin structure had been added on top of the hull effectively raising the centre of gravity and increasing the wind area.

2.4 The *Uean Te Raoi II* was constructed from imported *materials*, there being no viable native wood supplies available. The beams that connected the outrigger to the main hull were reported to be 5.8 m long which gave an offset of 4.5 m centre to centre. The length of these beams was governed by the maximum length of wood that could be imported into the country in a standard international standard twenty-foot equivalent unit container. A greater offset could have been achieved by extending the length of the beams by using two or more lengths of wood together. However, the boat-builder was concerned that the beam would be more likely to fail at the weak spot of a join and he had built the *Uean Te Raoi II* so it would be able to be used through the culvert under the causeway between Bairiki and Betio.

2.5 The *Uean Te Raoi II* was constructed with the outrigger on the port side in line with tradition. In operation, when the vessel rolled to port the outrigger was forced into the water thus increasing the buoyancy force on the outrigger and forcing the vessel back upright. When the vessel rolled to starboard the outrigger lifted in the water, the buoyancy force decreased and the apparent weight of the outrigger increased bringing the vessel back to the upright. If the outrigger went fully under the water or out of the water there was no further increase in righting force provided (see Figure 3). The outrigger could not be made more buoyant than it was, but the weight could be increased by adding ballast to the outrigger to prevent the outrigger lifting. This ballast could be in the form of solid ballast or human ballast as in members of the crew. The 2 forward beams of the outrigger were "decked" over to provide a means for the crew to gain access to the outrigger for this purpose.

2.6 The builder claimed that there were large reserves of buoyancy created by the outrigger to prevent capsize in that direction, and without calculation, that would appear to be the case. However, the independent naval architect noted in his report that the increase in the size and weight of it may have been proportionally smaller than the increase in size of the main hull and would therefore be more prone to capsize.

2.7 The naval architect noted:

> Taking account of all these points, the relative safety of the *UTR2* vessel is probably less than 60% of that achieved by the *KIR-5A* design. While the *UTR2* may be loosely based on the *KIR-5A* design, the differences are so extensive that it is not realistic to claim that one is simply an extension of the other proven design. The *UTR2* is a fundamentally different vessel, with respect to its layout, load carrying ability, and stability parameters.

2.8 Because there were no known criteria that set an acceptable stability limit for outrigger vessels, the naval architect used a stability criteria that was broadly based on one of 9 points that make up Maritime Rules Part 40A (Government of New Zealand, 2000). This point taken by itself would lead to a vessel that was somewhat less safe than would normally be acceptable in a country such as New Zealand. The naval architect then carried out a series of calculations based on a number of operating conditions (see Appendix 2) which showed:

> With this loading [52 persons and 1000 kg cargo], and offset at an average of 100 mm to leeward, and 10 kts. of wind, the vessel would have had a reserve of stability against capsize of approximately 38%. It would therefore have met the nominated criteria above. However the capsize angle is only 17 deg, and so a modest amount of wave action from the windward direction would be likely to cause capsize.
>
> Alternatively, if the effects of offset load and wind are ignored, then the vessel has an adequate stability reserve, although the capsize angle is still only 22 degrees. In seas that have an effective wave height of about 1.6 m or more (crest to trough), and acting in a manner where they lift the outrigger by this amount relative to the main hull, it is likely that a complete capsize could occur.
>
> … as a general guide, a 75 kg. person placed near the outrigger end of the cross beams would improve the stability characteristics by about 15%.
>
> … The vessel did not provide an acceptable level of safety in anything beyond sheltered waters.

2.9 The skipper and crew of a vessel having knowledge of the stability limitations of their vessel are crucial to safe operation. Recognising when those limits might be exceeded and taking corrective action is knowledge that all skippers should possess, and should be considered in their training. The skipper on this occasion was inexperienced, and it is not known what instruction he had received, but his reported indifference to how the *Uean Te Raoi II* was performing shortly before the capsize is suggestive of a lack of understanding of the limitations of his vessel. Whether this is an isolated case with this skipper or symptomatic of the general knowledge base within the maritime community was not known.

2.10 The way a vessel is loaded plays an important part of calculating and understanding its stability. The *Uean Te Raoi II* was reported to have been assigned the numbers of 40 passengers and 5 crew as its maximum loading. This maximum was estimated by the builder as being reasonable based on the average weight of 75 kg for each passenger. Reports reveal that there were 52 persons on board and an estimated 1000 kg of personal effects and cargo stored under deck. Compared with the boat builder's estimations the vessel was overloaded. Witnesses reported that when the vessel departed on the accident trip the main hull was sitting low enough in the water so that the buoyancy from the outrigger was causing the vessel to list away from the outrigger, to starboard. This would have had an effect on the stability in 2 ways. The inherent stability of the main hull might have been reduced, and the vessel had a pre-existing list to starboard, which would have eroded some reserve stability.

The accident

2.11 With its relatively shallow draft and narrow hull the *Uean Te Raoi II* relied heavily on the single outrigger to provide a righting arm (lever) against capsize when the vessel was heeled by the sea and/or wind. Buoyancy from the outrigger provided a lever to prevent the vessel capsizing toward the side of the outrigger.

2.12 Capsize in the other direction however, relied on the sum of the weight of the outrigger and the distance that weight was displaced from the centre of gravity of the main hull. As the outrigger rises out of the sea when the vessel rolls, the downward weight increases (and thus the righting lever) as the outrigger rises clear of the water. If the capsizing moment caused by waves and wind was to exceed the righting lever provided by the outrigger, the vessel would continue to roll over towards the non-outrigger side. As the angle of heel increased, the righting lever provided by the outrigger would decrease to a point where the vessel was lying on its beam with the outrigger vertically up in the air, at which point the outrigger would provide no righting lever to prevent capsize.

2.13 The *Uean Te Raoi II* was travelling south with the outrigger positioned to seaward, toward what had become a significant wind and sea. Witnesses reported the outrigger rising out of the sea on several occasions before the actual capsize. Some were concerned enough to comment to the skipper, who from his reported response, was unconcerned and had what was possibly misplaced confidence in the vessel's ability to handle the sea conditions in the direction of travel at the time. The independent naval architect noted in his report that: "It is reported that the outrigger was becoming airborne at times, which indicates that the stability was marginal." He also noted earlier in his report that "for a vessel with the reported dimensions, a difference in height of 1 m between the outrigger and the main hull will cause a roll angle of about 14°".

2.14 There are 2 other factors that could contribute to the boat capsizing. The first is wind acting initially on the hull and superstructure and then on the "flying" outrigger; the second is the shift of cargo and passengers to the low side of the boat as the heel increased. The vessel was described as taking a larger roll with the outrigger rising up to some 2 m above the sea, hanging there for a short time and then the vessel capsizing. Survivors reported that passengers fell to the low side of the cabin through this sequence.

2.15 With the loading of about 52 persons and a tonne of cargo, a passenger and cargo offset of about 100 mm to the leeward side and approximately 10 knots of wind the *Uean Te Raoi II* would have had a reserve of stability against capsize of approximately 38%. It would therefore have met the nominated criteria mentioned in the independent naval architect's report. However, the report noted that the capsize angle was only 17°, so a modest amount of wave action from windward would have been likely to cause a capsize. Alternatively, if the effects of an offset load and the wind were ignored, then the vessel would have had an adequate stability reserve but, the capsize angle was still only 22°. In seas that had an effective wave height of about 1.6 m or more acting in a manner where they lift the outrigger by this amount relative to the main hull it was likely that a complete capsize could have occurred. The vessel did not provide an acceptable level of safety in anything beyond sheltered waters (Stronach & Associates, 2009).

Search and Rescue

2.16 The Director of Marine was required to sign an authorisation before a search and rescue operation could be undertaken. Valuable time was lost while the Marine Division tried to locate the Director of Marine. The Director of Marine had a cellphone that he had lodged with the Marine Division but the number was out-of-date so other than physically tracking him down he was in effect uncontactable.

2.17 Unless the Director of Marine issued a written authority, as he did if he was absent from the country, there was no-one in the Marine Division with the authority to give sanction for a search and rescue operation in his absence. A more prudent approach, realising the difficulty with communications within the islands and the island would be to have a documented chain of authority that could be used in an emergency such as this and for the information held by the Marine Division and other divisions within the Government to be kept current.

2.18 Kiribati Marine Division operated on a high-level quality manual, part of which concerned search and rescue. The manual laid down the duties of a mission co-ordinator in the event of an emergency, the Director of Marine in this case, but only dealt with the broad aspects of the search and rescue. The production of a lower-level, more detailed search and rescue plan may have aided the Director of Marine in his duties as a mission co-ordinator and other agencies such as the Police in carrying out the search and rescue. Such a plan would give all participants something to train against and to measure their success.

2.19 Kiribati did not have a documented search plan, although once notified of the accident the Director of Marine was able to organise a search in about 4 hours. In determining the search area for the *RKS Teanoai* the Director of Marine did not have access to the software available to other RCC's but had to manually calculate the drift pattern. Manual calculation of drift patterns is difficult and is time and labour-intensive. RCCNZ operatives for example were trained in the method of manual calculation so that they understood the basic principles, but used a software programme as this was quicker and less prone to error.

2.20 The Director of Marine only had access to wind and current data that was not as up-to-date as that used by the RCCNZ software programme, which used near real time data from satellites and the MetService. This would help to explain the disparity in the search area determinations between Kiribati and New Zealand.

2.21 As Figure 2 shows neither search area was entirely accurate. The area where survivors, victims and debris were recovered lay somewhere between the 2 areas. A successful search and rescue operation is reliant on good technical resources, local knowledge and good communications between those involved in the operation.

2.22 When the P3 Orion was conducting the search the crew on-board said they noticed the first items of debris in an "eddy line" where the debris from the accident had drifted in a generally northward direction. This and other associated eddies which are unpredictable and often uncharted could explain why the drift calculations used in each search by the rescue craft were less than optimal.

2.23 Had Kiribati entered into formal agreements or memoranda of understanding with neighbouring states that had rescue coordination centres, Kiribati would probably have been able to call on one of these states to provide a search area determination quicker than it could produce one. However, to accurately predict a search area the information must be as accurate and as up-to-date as possible and any unknown factor, such as the undocumented tidal rip current in this case, can make even the best search area determination inaccurate.

2.24 Once local fishermen had found survivors and this information was known on the island of Tarawa the New Zealand High Commission informed RCCNZ which was able to direct the search aeroplane to a new search area. The aircraft was then able to provide assistance in pinpointing the position of debris and bodies for the on-scene boats to recover. This search and rescue showed how efficient communications at all levels between all parties engaged can enhance the search and rescue effort.

Survivability

2.25 This accident happened at around midday. A number of survivors swam ashore and were able to report the accident some 4 hours later. The search was initiated, but for reasons given above the calculated drift pattern from the reference point for the search was in a different direction to that which the upturned boat followed. Consequently the search was undertaken in the wrong area for about 2½ days.

2.26 From witness accounts 2 persons died almost immediately as a result of the accident. Apart from those who swam ashore to raise the alarm the remainder who stayed with the up-turned boat survived for a number of days in the water. Several later left the boat either through frustration at not being rescued or simply succumbed to exhaustion and slipped away.

2.27 Had an EPIRB been on-board and activated, the exact location and plight of the *Uean Te Raoi II* would have been known almost immediately. In this event it is highly likely that all of those on-board would have been rescued that night, meaning the number of fatalities would have been kept at 2.

2.28 The second point is that throughout the first night the survivors could see the searchlight from the searching patrol boat, and through the next day several fishing boats were seen on the horizon. Had day and night flares been available these would almost certainly have alerted the search boat or other craft to the location of the survivors. This too could have reduced the number of fatalities to 2.

2.29 The third point is that there were not enough life jackets on board for every person, and there were none suitable for small children. The life jackets were not easily accessible, having been over-stowed with personal belongings and cargo within the main hull. It is feasible that more people would have survived if suitable lifejackets had been available for all on-board.

2.30 This accident highlights the importance of having the appropriate safety equipment on-board, and having it stowed in a position where it is easily accessible.

Climatic conditions

2.31 The weather described by the witnesses was similar to that supplied by the MetService (see Appendix 1), and was not unusual for the time of year. The wind estimated to be Beaufort force 4 gives a range between 11 and 16 knots; this would produce one to 2 metre high seas. The area in which the vessel capsized was known for rougher seas caused by tidal eddies and overfalls. As the stability analysis shows seas of this size were highly likely to cause the *Uean Te Raoi II* to capsize.

2.32 Kiribati did not produce its own weather forecasts, but relied upon those supplied by the Meteorological service in Fiji. These forecasts were acknowledged to have been received twice daily by the Meteorological Division in Kiribati and were distributed to the local radio station for use. Once distributed to the local radio station the Meteorological Division had no further control over how the forecasts were disseminated and could not guarantee that they were broadcast or, if they were in what format. It would be useful for the Meteorological Division to enter into an agreement with the Marine Division for the supply of weather forecasts to the Marine Division. The Marine Division could then promulgate the forecasts for use by mariners. This promulgation could include displaying the weather forecast at the entrance to the harbour in Betio. Skippers of the interisland vessels could then make an informed decision on whether to sail or not. Passengers destined to board vessels in Betio would also have access to this information, which would allow them to make a decision on whether they wished to sail on a vessel on a particular day. However, a weather forecast published in this manner would not have been of use to the skipper or passengers of the *Uean Te Raoi II* as the vessel did not leave from Betio but from Teaoraereke so another method of promulgation would be required for "outports" and other islands, possibly by radio broadcast.

Legislation

The Merchant Shipping Act

2.33 The definition of 'vessel' in Section 2 of the Merchant Shipping Act expressly excludes canoes, vessels propelled by oars and patrol boats, for example:

> "ship" includes –
> (a) in relation to the ownership of a ship, a share in the ship and any interest in the ship or share; and
> (b) every description of a vessel used, or capable of being used, in navigation by water, but does not include –
> i) a canoe ;
> ii) a vessel ordinarily propelled by oars; or;
> iii) a vessel belonging to the Police Force or the defence forces of any other country

Accordingly, these types of vessels are expressly excluded from the general provisions of the Merchant Shipping Act

2.34 Section 2B of the Merchant Shipping Act, however, incorporates a number of international conventions into Kiribati law. These conventions are set out in the second schedule to this Act. Some of the conventions apply to a wider class of vessels than provided for in the Merchant Shipping Act. Advice received from the Attorney General for Kiribati, however, confirmed that where a wider class of vessels is provided for in one of the scheduled international conventions, then the provisions of that convention will apply to all such vessels notwithstanding the limited definition of "ship" in the Merchant Shipping Act. In other words, the limited definition does not restrict the application of any of the scheduled conventions.

2.35 A number of the conventions to which Kiribati has acceded are applicable to all vessels. For example, the collision regulations require all craft to follow the same set of "rules of the road", to have navigation lights, and to have sound signals and day shapes. Another is Annex IV of the marine pollution convention, which set a requirement that no plastics may be discharged from any vessel into the sea. Another is Annex I of the marine pollution convention, which set a requirement that no craft may discharge oil into the sea unless it is at a dilution of 15 parts per million or less. To the knowledge of the Commission, few of the local boats observed were fitted with navigation lights. Compliance with the other requirements mentioned above was not tested.

2.36 Although Section 2B of the Merchant Shipping Act makes these international conventions part of the law of Kiribati, no significant regulatory infrastructure existed within Kiribati to ensure that these international requirements could be implemented and complied with. For example, no real ability existed to enforce the requirements and there were no penalties for lack of compliance by owners and/or masters. Also of note is that there was no guidance or education material, or even the availability of the Acts in the national language. This meant owners of small craft were likely to be unaware of their responsibilities under these conventions.

2.37 Acceding to IMO conventions places a moral and legal obligation on the Government of Kiribati to implement the conventions in full and provide services required by the conventions or follow the instructions within them. Listing the conventions in a schedule does not fulfil this obligation. As an example, the search and rescue convention under clause 2.2.1 requires that parties shall establish appropriate national procedures for overall development, co-ordination, and improvement of search and rescue services. This inquiry showed that Kiribati had no search and rescue plan and therefore did not comply.

2.38 Countries signing up to IMO conventions, but doing little to comply with them, is a major concern for maritime safety both internationally and within a state, more so when countries run an open register allowing foreign ship owners to register their ships with that state. Historically some open ship registers have been accused by the international maritime community as being havens for substandard ships. There has been no evidence that this is the case with the Kiribati open register, but with a high level of non-compliance with the IMO conventions it has the potential to be. The resources required to administer a local ship register, let alone an open register, are not insignificant; more than what the Kiribati Marine Division currently have. The Kiribati Government would benefit from conducting a review of the true costs of properly resourcing an open register and comparing this with the financial benefits. The results of such a review are likely to show that resources could be better diverted to establishing an efficient local register first, with an option of establishing an open register in the future once the expertise and resources have been accumulated.

2.39 Another point potentially related to this inquiry was that under Article 98 of the United Nations Law of the Sea convention every state shall require the master of a ship flying its flag, in so far as he can do so without serious danger to the ship, the crew or the passengers:

- To render assistance to any person found at sea in danger of being lost;
- To proceed with all possible speed to the rescue of persons in distress, if informed of their need of assistance.

Neither the Merchant Shipping Act nor Shipping Act contain any such clauses obligating ships under the Kiribati flag to provide any form of assistance to persons in distress at sea.

The Shipping Act

2.40 Due to the definition of a vessel there is no requirement for vessels which operate solely within the island lagoons to hold a certificate of seaworthiness or a licence to trade. Some of these lagoons can be of significant size and craft may be travelling 30 to 40 km with passengers and/or cargo without having to comply with any standards governing their operation. It is therefore feasible that if the Marine Division does try to enforce the requirement to hold seaworthiness certificates and licences to trade on vessels operating across lagoons, any legal challenge to that requirement would be successful.

2.41 Except for the exclusions within the definition of a vessel, the Shipping Act applies to all vessels, pleasure, commercial, fishing, cargo or passenger, powered or unpowered, large or small, Kiribati flagged or foreign flagged. Therefore all vessels which operate beyond the lagoon technically must hold a seaworthiness certificate and a licence to trade; this could be many hundreds of craft spread across the atolls of Kiribati. The Marine Division did not know how many vessels (from canoes to 1,000 GRT inter-atoll ships) that existed in Kiribati, and therefore it is unlikely that all these vessels are in compliance with the Shipping Act. The resources required to regulate this volume of activity were not available with the Marine Division, even if it comprised its full membership of 3 persons.

2.42 With limited resources the Marine Division applied their own interpretation on the Act by only applying the requirement for seaworthiness certificates and licence to trade to larger craft and craft carrying passengers or cargo. While this might on the face of it appear to be a pragmatic solution to the problem, it was the inconsistent application of standards that might also be open to a legal challenge from those who were regulated over those that were not.

2.43 The Shipping Act does empower the Minister to make regulations in support of the Act, but to date this has not happened. Without the underpinning regulations there are in effect no standards to apply to any vessel in order to grant a seaworthiness certificate or licence to trade, other than for an owner to pay the prescribed fee.

Uean Te Raoi II

2.44 According to the Shipping Act the *Uean Te Raoi II* was required to hold a seaworthiness certificate and a licence to trade. The owner made the necessary applications and paid the required survey and licence fees. The Marine Division applied the standards for the carriage of equipment that it had been applying to this type of vessel for some time, but these standards were not based on any law, because there were no regulations setting out the standards. The survey required the carriage of lifejackets (one for each person), a radio, a compass, and an EPIRB. The surveyor did not issue a seaworthiness certificate or a licence to trade, because there was no EPIRB on board. Even though this was a prudent piece of equipment to carry, because there was no regulation requiring its carriage, the surveyor should not have withheld the licence on those grounds alone. Notwithstanding this, the *Uean Te Raoi II* should not have embarked on the revenue trips that it did, including the trip when the accident occurred, because neither a seaworthiness certificate nor a licence to trade had not been issued.

3 Findings

3.1 The *Uean Te Raoi II* capsized to starboard, the side that had no outrigger, because of 3 reasons: the direction of travel placed the outrigger to windward and the reserves of stability were overwhelmed by a combination of wave action rolling the vessel to starboard forcing the outrigger clear of the water, wind acting on the "flying" outrigger, and the passengers sitting within the cabin falling to the low side.

3.2 The size of the *Uean Te Raoi II* differed considerably from the design that it was based on. As the size of all components had not been increased proportionately the reserves of stability had been eroded to a point where the vessel was only suitable for use in sheltered waters.

3.3 The *Uean Te Raoi II* did not have a certificate of seaworthiness, nor a licence to trade so it should not have been undertaking the voyage it was on when it capsized.

3.4 Had the *Uean Te Raoi II* carried a 406 MHz EPIRB ready for immediate use, it is highly likely that only 2 instead of 35 persons would have died.

3.5 Had the *Uean Te Raoi II* carried day and night flares ready for immediate use, it is highly likely that only 2 instead of 35 persons would have died.

3.6 Had the *Uean Te Raoi II* carried an appropriate life jacket for each person on board ready for immediate use, it is likely that the number who died could have been reduced.

3.7 The Marine Division did not have an effective search and rescue plan that could be implemented at short notice, delaying the commencement of the search for survivors.

3.8 Had the Marine Division entered into formal agreements or memoranda of understanding with the countries that provided search and rescue coverage in the oceanic regions in which the Kiribati coastal waters lay, more immediate help in determining search areas would have been available.

3.9 The Marine Division did not have sufficient resources to effectively administer the provisions of the Merchant Shipping Act and the Shipping Act.

3.10 The Shipping Act did not have any underpinning regulations to set appropriate standards of safety in the Kiribati domestic fleet.

3.11 Kiribati is not meeting its obligations under the various IMO conventions that it has acceded to.

3.12 The Marine Division does not have sufficient resources to properly discharge Kiribati's responsibilities under the IMO conventions it has acceded to.

4 Safety Recommendations

The Kiribati Commission is invited to consider the following safety recommendations which have been developed from the inquiry into the complete Kiribati maritime system as outlined in the terms of reference.

4.1 That the Kiribati Government accept this final report and considers implementing the recommendations to address any safety issues identified.

4.2 That the Kiribati Government provide the Marine Division with additional resources to enable better monitoring of passenger, non-passenger and fishing vessels to ensure they hold certificates of seaworthiness and licences to trade. Some consideration should be given to using the Police maritime unit to assist with compliance.

4.3 That the Marine Division issues a safety bulletin highlighting the dangers of overloading vessels and that under the Shipping Act a passenger is deemed to be anyone who is not crew and is over the age of one year. Until some form of load line is adopted the Marine Division should consider issuing a recommendation or instruction to vessel owners that where carrying the maximum number of passengers would sink a vessel down to its design load mark, that for every 75 kg of cargo carried the maximum number of passengers, as listed on the licence to trade, is reduced by one.

4.4 That the Marine Division recommend the carriage of sufficient children's lifejackets when children are carried on any voyage.

4.5 That the Marine Division develops and distributes a laminated simple guidance notice for vessel owners of what equipment is recommended to be carried. This guidance should be in the local language and pictorial, similar to the one produced by the SPC appended to this report (the SPC might be approached to assist with this project).

4.6 Consider amending the definition of "vessel" within the Shipping Act so that passenger, non-passenger (cargo) and fishing vessels operating within a lagoon are required to hold seaworthiness certificates and licences to trade.

4.7 Consider implementing a "freeboard" mark on the side of cargo and passenger craft. This mark could be similar to that under New Zealand's Maritime Rules Section 2 of part 47 for cargo/passenger vessels or Maritime Rule 40A.15 for vessels that only carry passengers. Alternatively Volume 1 Part 2 "assignment of load lines" of the Secretariat of the Pacific Community Survey Instructions and Guidelines for Surveyors may be considered appropriate.

4.8 The Marine Division to issue instructions or guidance highlighting that under Article 98 of the United Nations Laws of the Sea convention, all Masters have a duty to render assistance to any person or ship found at sea in danger of being lost.

4.9 The Marine Division is to enter into formal agreements or memoranda with the countries whose search and rescue areas cover parts of the Republic of Kiribati exclusive economic zones; Fiji, New Zealand, Nauru, United States of America and Tahiti.

4.10 The Marine Division develop an effective search and rescue plan that could be launched at short notice and not be exclusively dependent on the availability of single-point resources.

Longer-term recommendations

4.11 The Kiribati Government is to seek assistance from the IMO technical cooperation fund to review the Shipping Act to align it with the model legislation being developed by the IMO for non-convention ships. Any review should also develop and implement regulations, training for surveyors and enforcement officers, and provide education material for vessel owners. The review should also focus the requirement for the holding of sea worthiness certificates and licences to trade to appropriate vessels.

4.12 Consider amending the Merchant Shipping Act and / or the Shipping Act to ensure Article 98 "Duty to render assistance" is reflected in Kiribati legislation.

4.13 Consider reviewing all of the international conventions to ensure that any requirements imposed on "near coastal" vessels are reflected within the legislation and guidance developed under item 1 above. One option to achieve this would be for the Kiribati Government volunteering for audit by the IMO under the IMO Voluntary Member State Audit Scheme. The results of this audit would enable Kiribati to make a case for funding and assistance from the IMO and other states or international bodies.

4.14 Consider conducting a cost versus benefit review of Kiribati operating an open shipping register. Cost should be calculated on realistic resources required to achieve total compliance with IMO conventions, and then consider whether resources might be better used to improve compliance for the local shipping register and improving safety within the local non-convention fleet.

4.15 Consider seeking international funding and assistance for ongoing and long term education of all vessel owners, masters and vessel operators of the risks of travel at sea. The project could be similar to that of the Torres Strait Marine Safety Strategy, with the objective of improving safety, reducing the loss of life and reducing the cost of search-and-rescue operations.

Approved on 25 February 2010

Hon. W P Jeffries
Chief Commissioner

Appendix 1

MetService report into weather and sea conditions

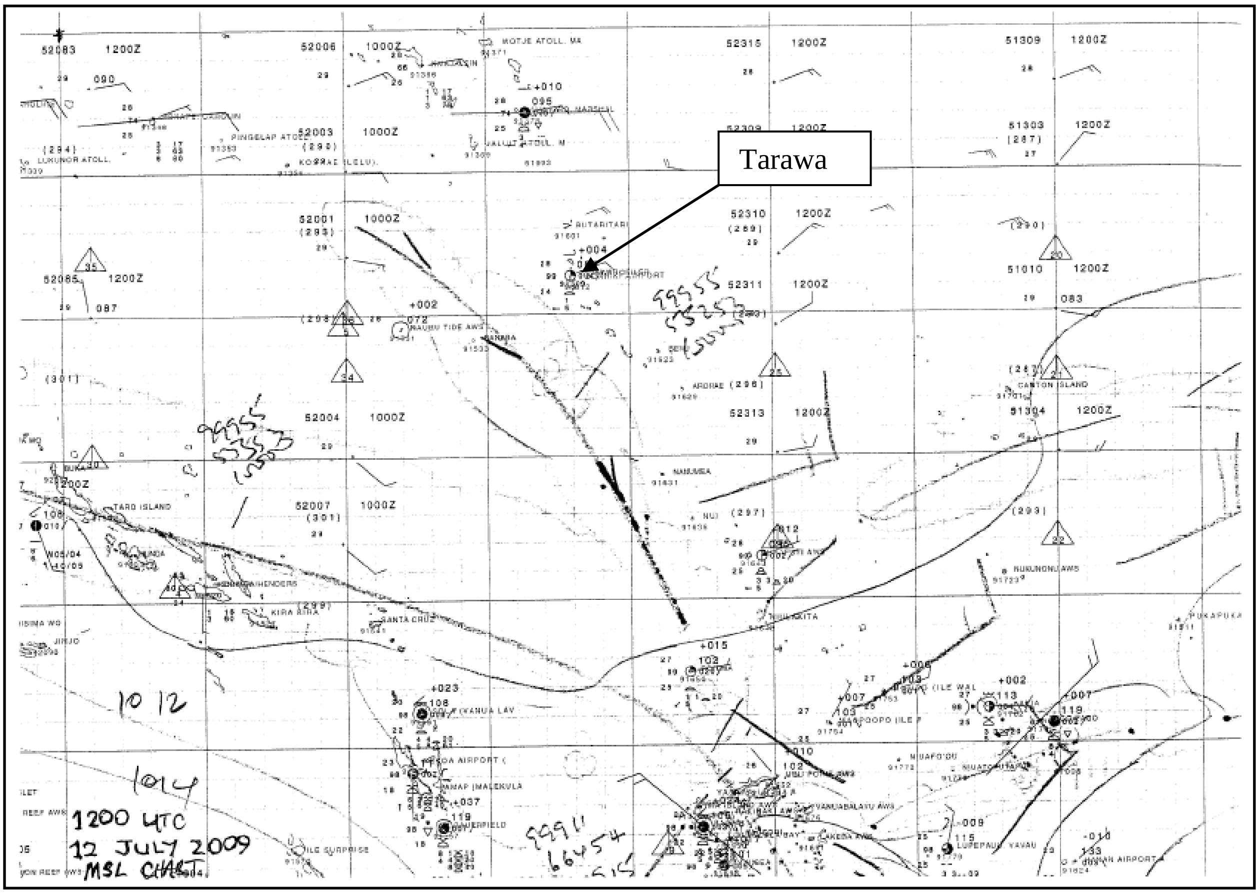
Meteorological Situation

These analysis charts have been provided by ı, Principal Scientific Officer, Fiji Meteorological Service.

A portion of each Fiji Meteorological Service MSL Analysis chart 12 hour intervals between 1200 UTC 12 July 2009 and 1200 UTC 16 July 2009 are reproduced here with a short description of the meteorological situation.

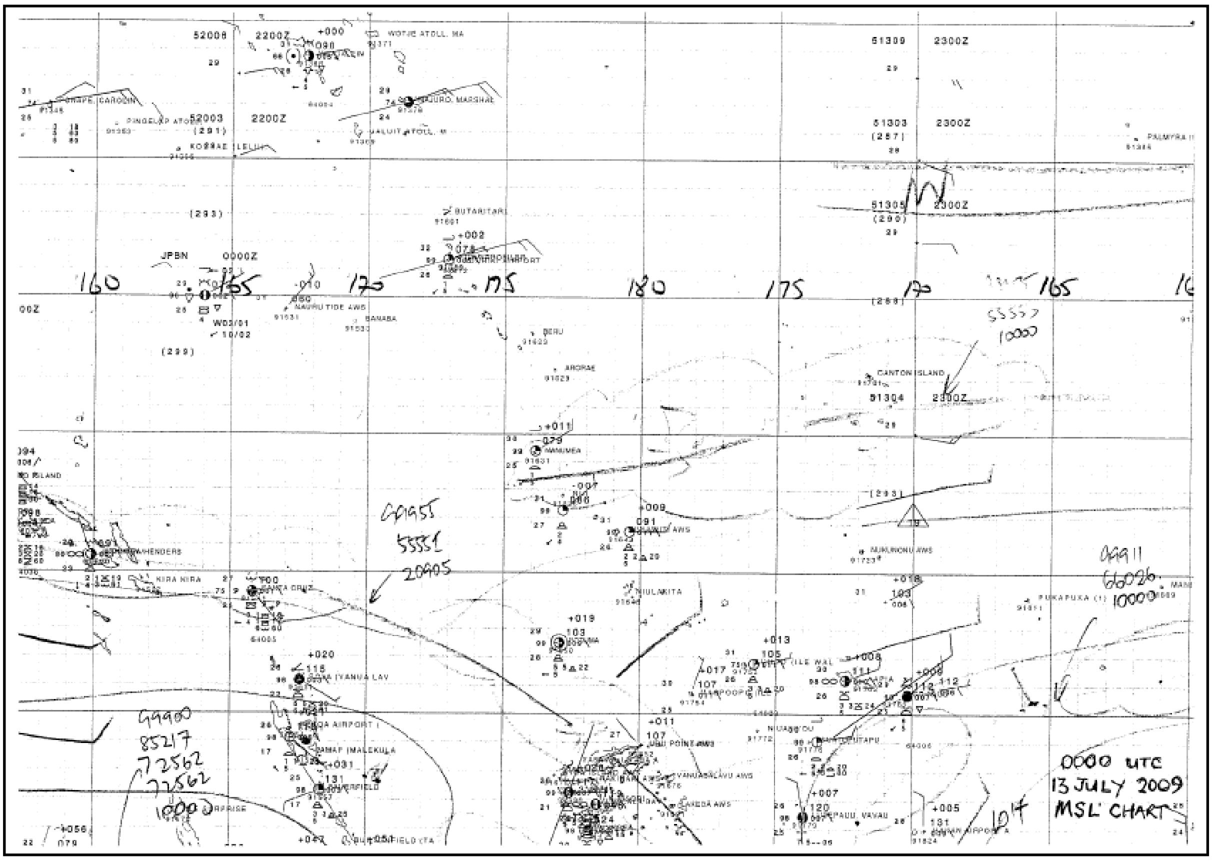
These chart portions approximately cover the area from 5°N 155°E in the northwest corner to 20°S 165°W in the southeast; latitude and longitude lines are at 5° intervals. In these charts Fiji can easily be identified in the lower centre between 15 and 20°S, and 175 and 180°E. Tarawa, about 1° north of the Equator, is the station in the upper centre (with its name obscured), but Butaritari is clearly labelled about 2 degrees of latitude to the north of Tarawa.

1200 UTC 12 July 2009



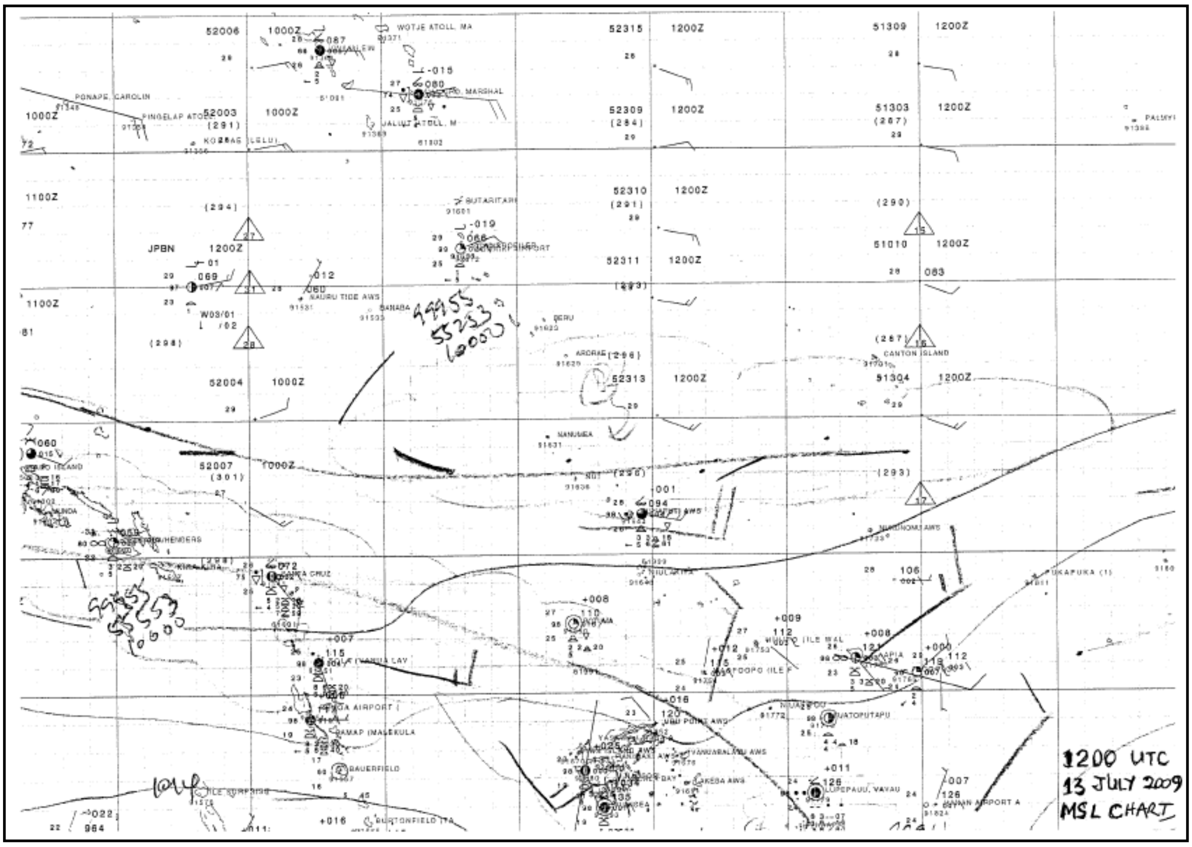
A convergence zone lies to the southwest of Kiribati, and an east to northeast wind flow covers the area in the vicinity of Tarawa.

0000 UTC 13 July 2009



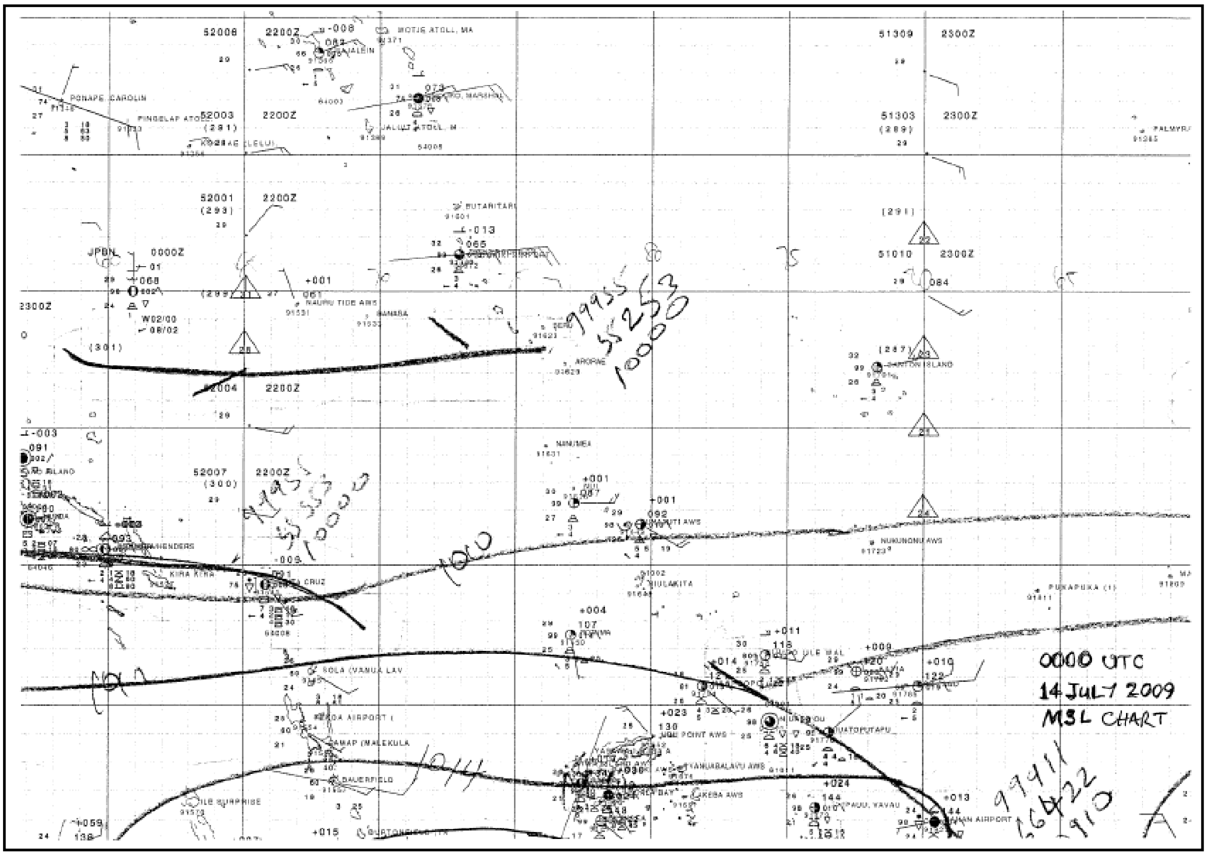
An east to northeast wind flow covers the area in the vicinity of Tarawa.

1200 UTC 13 July 2009



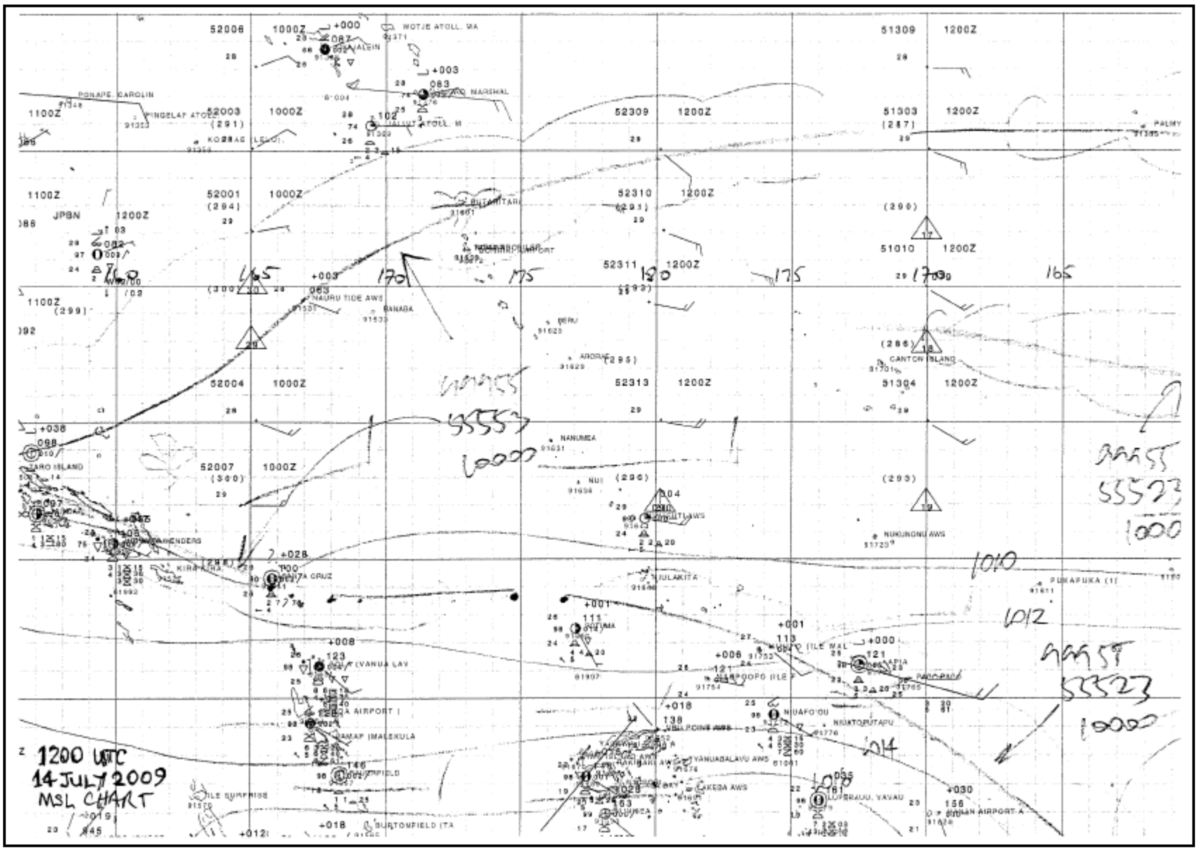
A convergence zone lies to the south of Kiribati and an easterly wind flow covers the area in the vicinity of Tarawa.

0000 UTC 14 July 2009



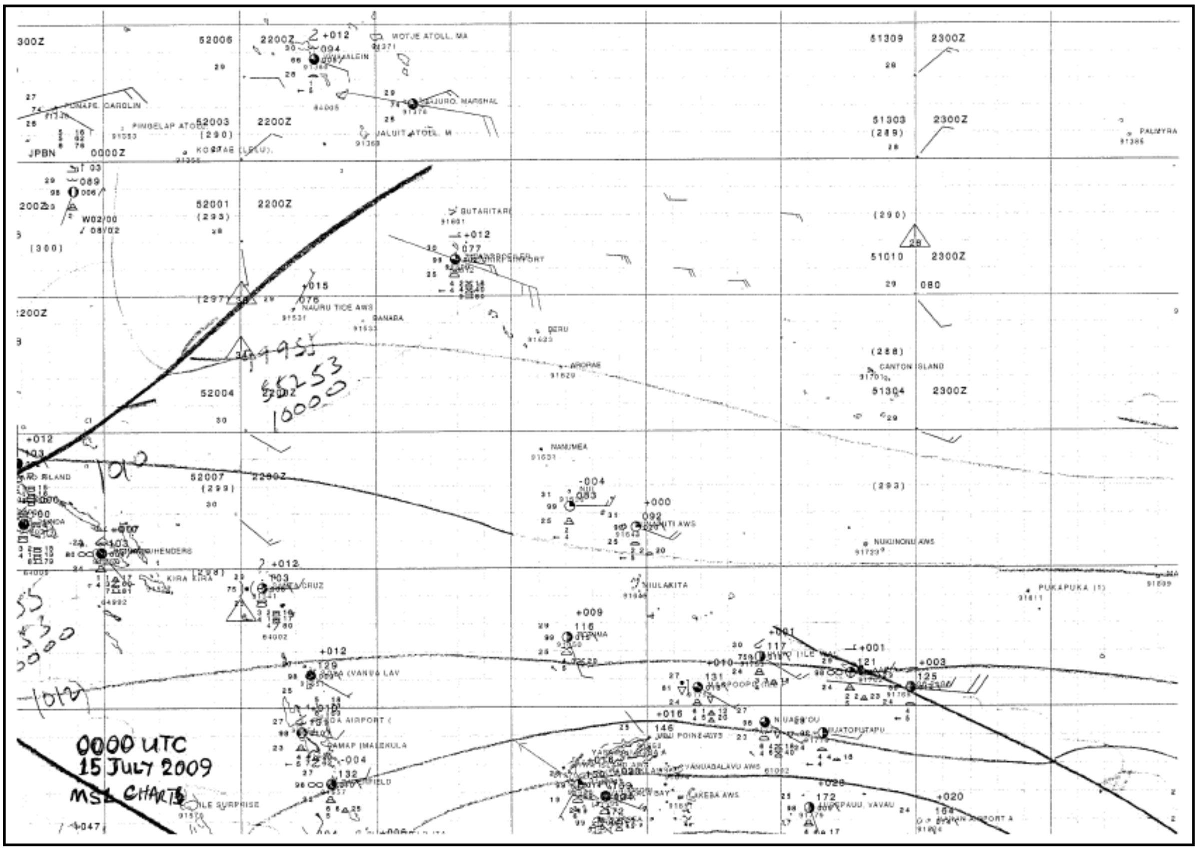
A convergence zone lies to the south of Kiribati and an easterly wind flow covers the area in the vicinity of Tarawa.

1200 UTC 14 July 2009



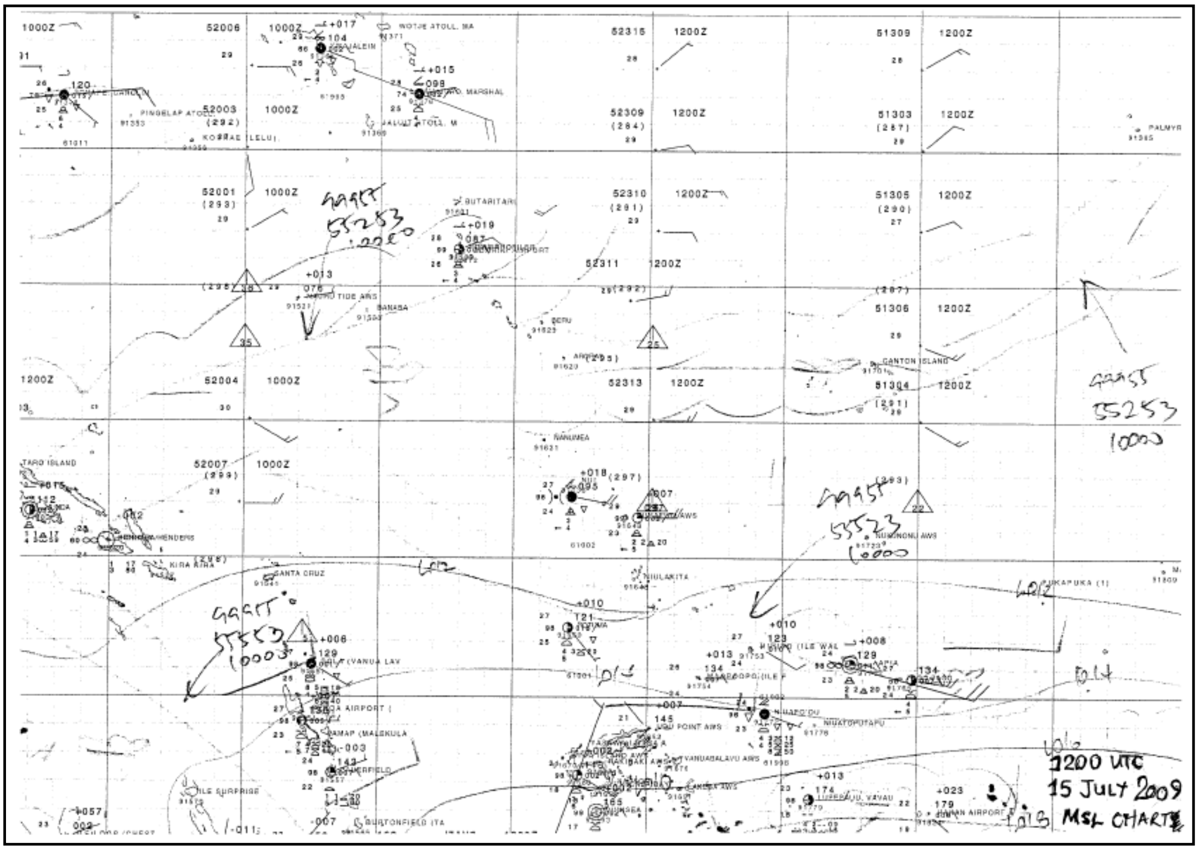
A convergence zone lies to the north of Kiribati and an easterly wind flow covers the area in the vicinity of Tarawa.

0000 UTC 15 July 2009



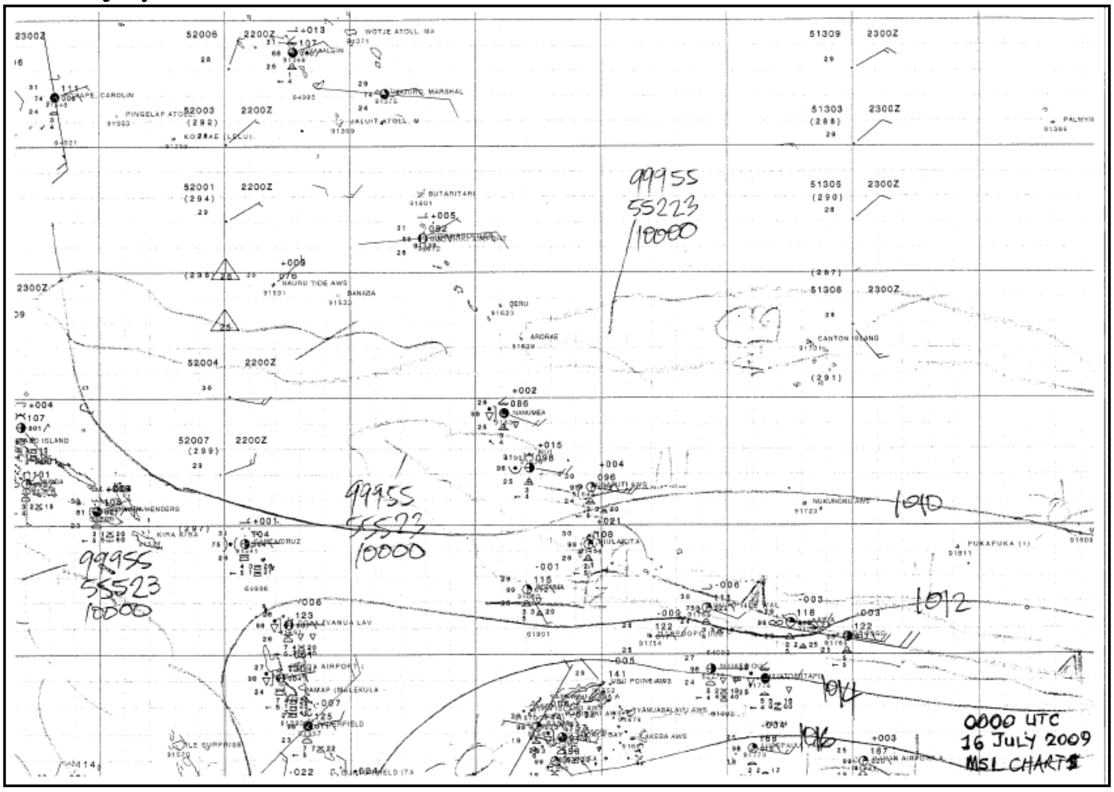
A convergence zone lies to the northwest of Kiribati and an east to southeast wind flow covers the area in the vicinity of Tarawa.

1200 UTC 15 July 2009



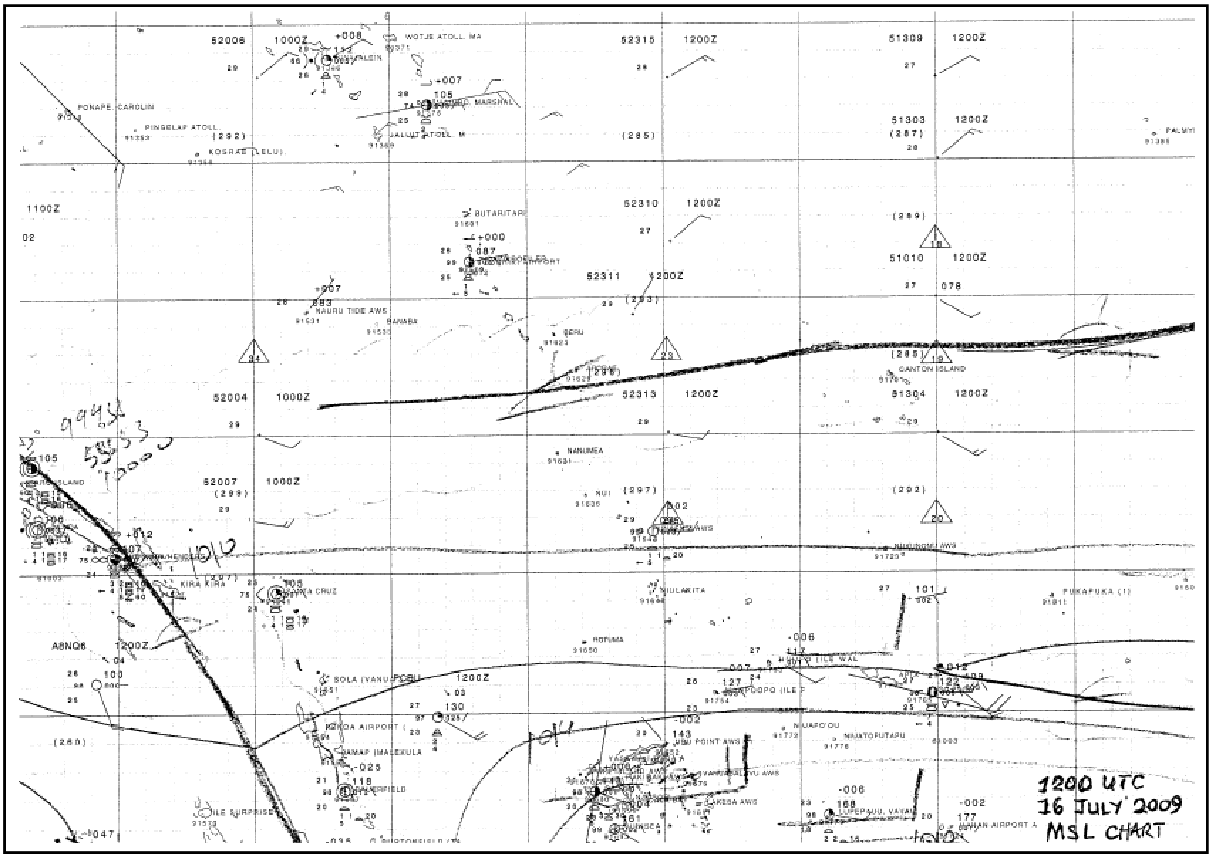
A convergence zone lies close to the northwest of Tarawa and a northeasterly wind flow covers the area in the vicinity of Tarawa.

0000 UTC 16 July 2009



A convergence zone lies to the south of Kiribati and an easterly wind flow covers the area in the vicinity of Tarawa.

1200 UTC 16 July 2009



A convergence zone lies to the south of Kiribati and a northeasterly wind flow covers the area in the vicinity of Tarawa.

Weather forecasts issued by Fiji Meteorological Service

Fiji Meteorological Service (FMS) issues two weather forecast bulletins for Kiribati and Banaba each day. The early morning issue at about 1630 UTC covers the period to midnight that day with an outlook for the next day. The afternoon issue at about 0300 UTC covers the period to midnight the next day with an outlook for the following day.

The forecasts cover the oceanic territory of Kiribati: the Gilbert Islands (usually referred to in the forecasts as western Kiribati), Rawaki (usually referred to in the forecasts as Phoenix Islands) which includes Canton Island, the Line Islands which includes Kiritimati (Christmas) Island, Tarawa and Banaba. The forecasts mention sea state and swell if they are considered by the forecaster to be significant – that is, if state of sea is expected to be moderate or higher, and/or the swell is expected to be moderate or higher. A "moderate sea" is WMO Sea State Code 4, and has waves with significant wave height of 1.25 to 2.5 metres. A moderate swell has significant wave height of 2 to 4 metres.

The significant wave height is the mean wave height of the one third highest waves.

The weather forecasts for Kiribati issued between 11 and 16 July 2009 have been retrieved from the FMS outward message archive and are reproduced below.

Each message has a two-line pre-amble consisting of a line with the filing and message despatch time and a message sequence number, and the second line consisting of product information and addresses for its delivery. The message terminates with a line consisting of "NNNN".

The body of the massage consists of several sections:

A heading containing the name of the island group, the subject of the message ("Weather Bulletin"), the issuing authority ("NWFC Nadi") meaning Fiji Meteorological Service at Nadi and a time. The time here is the time that the forecaster initiated the program used to compose the forecast.

A situation statement

The forecast for Kiribati and a "Further outlook"

The forecast for Tarawa and a "Further outlook"

The forecast for Banaba and a "Further outlook"

The message terminates with a line consisting of "NNNN".

Weather forecasts for Kiribati issued between 11 and 16 July 2009

These weather bulletins have been retrieved from the FMS weather message database, and were provided for this report by Alipate Waqaicelua, Principal Scientific Officer, Fiji Meteorological Service.

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2009-07-11 03:10Z 100274173
ZCZC AIFS_ID=10100 PROD MELB AKWBCYMYX XKIRINWS MES02 WEBF
Kiribati and Banaba
Weather Bulletin issued from NWFC Nadi Jul 110251 UTC.
Situation:
The weak Inter Tropical Convergence Zone [ITCZ] with associated cloud and showers
lies over the Southern Line Islands. Meanwhile, a moist esaterly wind flow covers
the entire group.
Forecast to midnight tomorrow for Kiribati
Moderate to fresh easterly winds, gusty at times. Moderate to rough seas.
For Western Kiribati: Cloudy periods with brief showers.
For Phoenix Islands: Cloudy periods with some showers and a possible thunderstorms.
For Northern Line Islands:Cloudy periods with some showers and a few thunderstorms
likely.
Southern Line Islands: Cloudy periods with occasional showers and thunderstorms.
Further outlook: Western Kiribati: Brief showers.
Phoenix Islands: Brief showers.
Northern Line Islands: Showers continuing.
Southern Line Islands: Cloudy periods otherwise fine.
For Tarawa:
Cloudy periods with brief showers.
Further outlook: Brief showers.
For Banaba:
Moderate easterly winds, gusty at times.
Cloudy periods with squally showers and thunderstorms. Moderate seas.
Further outlook: Brief showers.
NNNN
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2009-07-11 16:39Z 100293259
ZCZC AIFS_ID=10100 PROD MELB AKWBCYMYX XKIRINWS MES02 WEBF
Kiribati and Banaba
Weather Bulletin issued from NWFC Nadi Jul 111634 UTC.
Situation:
The weak Inter Tropical Convergence Zone [ITCZ] with associated cloud and showers
lies over the Southern Line Islands. Meanwhile, a moist esaterly wind flow covers
the entire group.
Forecast to midnight tonight for Kiribati
Moderate to fresh easterly winds, gusty at times. Moderate to rough seas.
For Western Kiribati: Cloudy periods with brief showers.
For Phoenix Islands: Cloudy periods with some showers and a possible thunderstorms.
For Northern Line Islands:Fine apart from a few cloudy periods.
Southern Line Islands: Cloudy periods with occasional showers and thunderstorms.
Further outlook: Western Kiribati: Brief showers.
Phoenix Islands: Brief showers.
Northern Line Islands: Fine.
Southern Line Islands: Cloudy periods otherwise fine.
For Tarawa:
Cloudy periods with brief showers.
Further outlook: Brief showers.
For Banaba:
Moderate easterly winds, gusty at times.
Cloudy periods with squally showers and thunderstorms. Moderate seas.
Further outlook: Brief showers.
NNNN
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2009-07-12 02:30Z 100306663
ZCZC AIFS_ID=10100 PROD MELB AKWBCYMYX XKIRINWS MES02 WEBF
Kiribati and Banaba
Weather Bulletin issued from NWFC Nadi Jul 120209 UTC.
Situation:
The Inter Tropical Convergence Zone [ITCZ] lies over Western Kiribati and weakens as
it extends eastwards over Northern Line islands. Meanwhile, an easterly windflow
prevails over the area.
Forecast to midnight tomorrow for Kiribati
Moderate to fresh easterly winds, gusty at times. Moderate to rough seas.
For Western Kiribati: Cloudy periods with brief showers and chances of a few
thunderstorms.
For Phoenix Islands: Cloudy periods with some showers and a possible thunderstorms.
For Northern Line Islands:Fine apart from a few cloudy periods.
Southern Line Islands: Cloudy periods with occasional showers and thunderstorms.
Further outlook: Western Kiribati: Brief showers.
Phoenix Islands: Brief showers.
Northern Line Islands: Fine.
Southern Line Islands: Cloudy periods otherwise fine.
For Tarawa:
Cloudy periods with brief showers.
Further outlook: Brief showers.
For Banaba:
Moderate easterly winds, gusty at times. Cloudy periods with squally showers and
thunderstorms. Moderate seas.
Further outlook: Brief showers.
NNNN
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2009-07-12 16:30Z 100326211
ZCZC AIFS_ID=10100 PROD MELB AKWBCYMYX XKIRINWS MES02 WEBF
Kiribati and Banaba
Weather Bulletin issued from NWFC Nadi Jul 121524 UTC.
Situation:
The Inter Tropical Convergence Zone [ITCZ] lies over the southern parts of Western
Kiribati and extends eastwards over Northern Line Islands. Meanwhile, another trough
lies over Phoenix Islands and extends east other the Southern Line islands.
Forecast to midnight tonight for Kiribati
Moderate to fresh easterly winds, gusty at times. Moderate to rough seas.
For Western Kiribati: Cloudy periods with brief showers and chances of a few
thunderstorms.
For Phoenix Islands: Cloudy periods with some showers and thunderstorms.
For Northern Line Islands:Showers and few thunderstorms over and north of Palmyra.
Elsewhere fine.
Southern Line Islands: Cloudy periods and possible brief showers.
Further outlook: Western Kiribati: Brief showers.
Phoenix Islands: Few showers and possible thunderstorms.
Northern Line Islands: Showers over and north of Palmyra.
Southern Line Islands: Cloudy periods otherwise fine.
For Tarawa:
Cloudy periods with possible brief showers.
Further outlook: Brief showers.
For Banaba:
Moderate easterly winds, gusty at times. Cloudy periods with possible showers.
Moderate seas.
Further outlook: Brief showers.
NNNN
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2009-07-13 02:30Z 100339425
ZCZC AIFS_ID=10100 PROD MELB AKWBCYMYX XKIRINWS MES02 WEBF
Kiribati and Banaba
Weather Bulletin issued from NWFC Nadi Jul 130208 UTC.
Situation:
The Inter Tropical Convergence Zone [ITCZ] lies over the southern parts of Western
Kiribati and extends eastwards over Northern Line Islands. Meanwhile, another trough
lies over Phoenix Islands and extends east other the Southern Line islands.
Forecast to midnight tomorrow for Kiribati
Moderate to fresh easterly winds, gusty at times. Moderate to rough seas.
For Western Kiribati: Cloudy periods with brief showers and chances of a few
thunderstorms.
For Phoenix Islands: Cloudy periods with some showers and thunderstorms.
For Northern Line Islands:Showers and few thunderstorms over and north of Palmyra.
Elsewhere fine.
Southern Line Islands: Cloudy periods and possible brief showers.
Further outlook: Western Kiribati: Brief showers.
Phoenix Islands: Few showers and possible thunderstorms.
Northern Line Islands: Showers over and north of Palmyra.
Southern Line Islands: Cloudy periods otherwise fine.
For Tarawa:
Cloudy periods with possible brief showers.
Further outlook: Brief showers.
For Banaba:
Moderate easterly winds, gusty at times. Cloudy periods with possible showers.
Moderate seas.
Further outlook: Brief showers.
NNNN
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2009-07-13 16:30Z 100359036
ZCZC AIFS_ID=10100 PROD MELB AKWBCYMYX XKIRINWS MES02 WEBF
Kiribati and Banaba
Weather Bulletin issued from NWFC Nadi Jul 131452 UTC.
Situation:
The Inter Tropical Convergence Zone [ITCZ] lies over the southern parts of Western
Kiribati and extends eastwards over Northern Line Islands. Meanwhile, another trough
lies over Phoenix Islands and extends east other the Southern Line islands.
Forecast to midnight tonight for Kiribati
Moderate to fresh easterly winds, gusty at times. Moderate to rough seas.
For Western Kiribati: Cloudy periods with some showers and few thunderstorms.
For Phoenix Islands: Cloudy periods with some showers and thunderstorms.
For Northern Line Islands:Cloudy period with some showers and few thunderstorms.
Southern Line Islands: Some showers and few thunderstorms.
Further outlook: Western Kiribati: Brief showers.
Phoenix Islands: Few showers and possible thunderstorms.
Northern Line Islands: Showers over and north of Palmyra.
Southern Line Islands: Cloudy periods with few showers and thunderstorms.
For Tarawa:
Cloudy periods with possible brief showers and thunderstorms.
Further outlook: Brief showers.
For Banaba:
Moderate easterly winds, gusty at times. Cloudy periods with some showers and few
thunderstorms. Moderate seas.
Further outlook: Brief showers.
NNNN
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2009-07-14 02:30Z 100372874
ZCZC AIFS_ID=10100 PROD MELB AKWBCYMYX XKIRINWS MES02 WEBF
Kiribati and Banaba
Weather Bulletin issued from NWFC Nadi Jul 140208 UTC.
Situation:
The Inter Tropical Convergence Zone [ITCZ] lies over the southern parts of Western
Kiribati and extends eastwards over Northern Line Islands. Meanwhile, another trough
lies over the Southern Line islands.
Forecast to midnight tomorrow for Kiribati
Moderate to fresh easterly winds, gusty at times. Moderate to rough seas.
For Western Kiribati: Cloudy with occasional rain and a few thunderstorms south of
Tarawa. Elsewhere, few showers and possible thunderstorms.
For Phoenix Islands: Cloudy periods with few showers.
For Northern Line Islands: Cloudy period with some showers and few thunderstorms.
Southern Line Islands: Some showers and few thunderstorms.
Further outlook: Western Kiribati: Brief showers.
Phoenix Islands: Few showers and possible thunderstorms.
Northern Line Islands: Few showers and possible thunderstorms.
Southern Line Islands: Cloudy periods with few showers.
For Tarawa:
Cloudy periods with brief showers and possible thunderstorms.
Further outlook: Brief showers.
For Banaba:
Moderate easterly winds, gusty at times. Cloudy with occasional rain and a few
thunderstorms. Moderate seas.
Further outlook: Few showers.
NNNN
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2009-07-14 16:30Z 100392299
ZCZC AIFS_ID=10100 PROD MELB AKWBCYMYX XKIRINWS MES02 WEBF
Kiribati and Banaba
Weather Bulletin issued from NWFC Nadi Jul 141545 UTC.
Situation:
The Inter Tropical Convergence Zone [ITCZ] lies active over the southern parts of
Western Kiribati and extends eastwards over Northern Line Islands. Meanwhile,
another trough lies over the Southern Line islands.
Forecast to midnight tonight for Kiribati
Moderate to fresh easterly winds, gusty at times. Moderate to rough seas.
For Western Kiribati: Cloudy with occasional rain and a few thunderstorms south of
Tarawa. Elsewhere, few showers and possible thunderstorms.
For Phoenix Islands: Cloudy periods with few showers.
For Northern Line Islands: Cloudy period with some showers and few thunderstorms.
Southern Line Islands: Some showers and few thunderstorms.
Further outlook: Western Kiribati: Brief showers.
Phoenix Islands: Few showers and possible thunderstorms.
Northern Line Islands: Few showers and possible thunderstorms.
Southern Line Islands: Cloudy periods with few showers.
For Tarawa:
Cloudy periods with brief showers and possible thunderstorms.
Further outlook: Brief showers.
For Banaba:
Moderate easterly winds, gusty at times. Cloudy with occasional rain and a few
thunderstorms. Moderate seas.
Further outlook: Few showers.
NNNN
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2009-07-15 02:30Z 100006272
ZCZC AIFS_ID=10100 PROD MELB AKWBCYMYX XKIRINWS MES02 WEBF
Kiribati and Banaba
Weather Bulletin issued from NWFC Nadi Jul 150208 UTC.
Situation:
The Inter Tropical Convergence Zone [ITCZ] lies active and slow moving just
northwest of Western Kiribati and extends eastwards over Northern Line Islands.
Meanwhile, an easterly windflow prevails over the islands.
Forecast to midnight tomorrow for Kiribati
Moderate to fresh easterly winds, gusty at times. Moderate to rough seas.
For Western Kiribati: Cloudy periods with some showers and a few thunderstorms north
of Tarawa. Elsewhere, brief showers.
For Phoenix Islands: Cloudy periods with few showers, becoming frequent tomorrow.
For Northern Line Islands: Cloudy period with occasional showers and few
thunderstorms.
Southern Line Islands: Fine apart from some cloudy periods with brief showers.
Further outlook: Western Kiribati: Brief showers.
Phoenix Islands: Few showers and possible thunderstorms.
Northern Line Islands: Some showers and possible thunderstorms.
Southern Line Islands: Mainly fine.
For Tarawa:
Cloudy periods with few showers.
Further outlook: Brief showers.
For Banaba:
Moderate easterly winds, gusty at times. Cloudy with occasional rain and a few
thunderstorms. Moderate seas.
Further outlook: Few showers.
NNNN
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2009-07-15 16:30Z 100026043
ZCZC AIFS_ID=10100 PROD MELB AKWBCYMYX XKIRINWS MES02 WEBF
Kiribati and Banaba
Weather Bulletin issued from NWFC Nadi Jul 151526 UTC.
Situation:
The Inter Tropical Convergence Zone [ITCZ] lies active and slow moving over Western
Kiribati and extends eastwards over the Northern Line Islands. Meanwhile, an
easterly windflow prevails over the islands.
Forecast to midnight tonight for Kiribati
Moderate to fresh easterly winds, gusty at times. Moderate to rough seas.
For Western Kiribati: Cloudy periods with some showers and a few thunderstorms north
of Tarawa. Elsewhere, brief showers.
For Phoenix Islands: Cloudy periods with few showers, becoming frequent tomorrow.
For Northern Line Islands: Cloudy period with occasional showers and few
thunderstorms.
Southern Line Islands: Fine apart from some cloudy periods with brief showers.
Further outlook: Western Kiribati: Brief showers.
Phoenix Islands: Few showers and possible thunderstorms.
Northern Line Islands: Some showers and possible thunderstorms.
Southern Line Islands: Mainly fine.
For Tarawa:
Cloudy periods with few showers.
Further outlook: Brief showers.
For Banaba:
Moderate easterly winds, gusty at times. Cloudy with occasional rain and a few
thunderstorms. Moderate seas.
Further outlook: Few showers.
NNNN
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2009-07-16 02:46Z 100040173
ZCZC AIFS_ID=10100 PROD MELB AKWBCYMYX XKIRINWS MES02 WEBF
Kiribati and Banaba
Weather Bulletin issued from NWFC Nadi Jul 160234 UTC.
Situation:
The Inter Tropical Convergence Zone [ITCZ] lies active and slow moving over Western
Kiribati and extends eastwards over the Northern Line Islands. Meanwhile, an
easterly windflow prevails over the islands.
Forecast to midnight tomorrow for Kiribati
Moderate to fresh easterly winds, gusty at times. Moderate to rough seas.
For Western Kiribati: Cloudy periods with some showers and a few thunderstorms.
For Phoenix Islands: Cloudy periods with some showers and a few thunderstorms north
of Canton. Elsewhere fine.
For Northern Line Islands: Fine apart from some cloudy periods with brief showers.
Southern Line Islands: Fine apart from a few cloudy periods.
Further outlook: Western Kiribati: Brief showers.
Phoenix Islands: Fine apart from few cloudy periods.
Northern Line Islands: Fine.
Southern Line Islands: Fine.
For Tarawa:
Cloudy periods with some showers and a few thunderstorms
Further outlook: Brief showers.
For Banaba:
Moderate easterly winds, gusty at times. Cloudy with occasional rain and a few
thunderstorms. Moderate seas.
Further outlook: Few showers.
NNNN
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2009-07-16 16:30Z 100059895
ZCZC AIFS_ID=10100 PROD MELB AKWBCYMYX XKIRINWS MES02 WEBF
Kiribati and Banaba
Weather Bulletin issued from NWFC Nadi Jul 161601 UTC.
Situation:
The Inter Tropical Convergence Zone [ITCZ] lies active and slow moving over Western
Kiribati and extends eastwards over the Northern Line Islands. Meanwhile, an
easterly windflow prevails over the islands.
Forecast to midnight tonight for Kiribati
Moderate to fresh easterly winds, gusty at times. Moderate to rough seas.
For Western Kiribati: Cloudy periods with some showers and a few thunderstorms.
For Phoenix Islands: Cloudy periods with some showers and a few thunderstorms about
and north of Canton. Elsewhere, mainly fine.
For Northern Line Islands: Cloudy periods with occasional showers and a few
thunderstorms
Southern Line Islands: Fine apart from a few cloudy periods.
Further outlook: Western Kiribati: Some showers over the southern parts..
Phoenix Islands: Cloudy periods some showers.
Northern Line Islands: Showers about and north of Christmas.
Southern Line Islands: Fine.
For Tarawa:
Cloudy periods with some showers and a few thunderstorms
Further outlook: Brief showers.
For Banaba:
Moderate easterly winds, gusty at times. Cloudy periods with occasional showers and
a few thunderstorms. Moderate seas.
Further outlook: Few showers.
NNNN
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Wind observations recorded at Bairiki, Tarawa

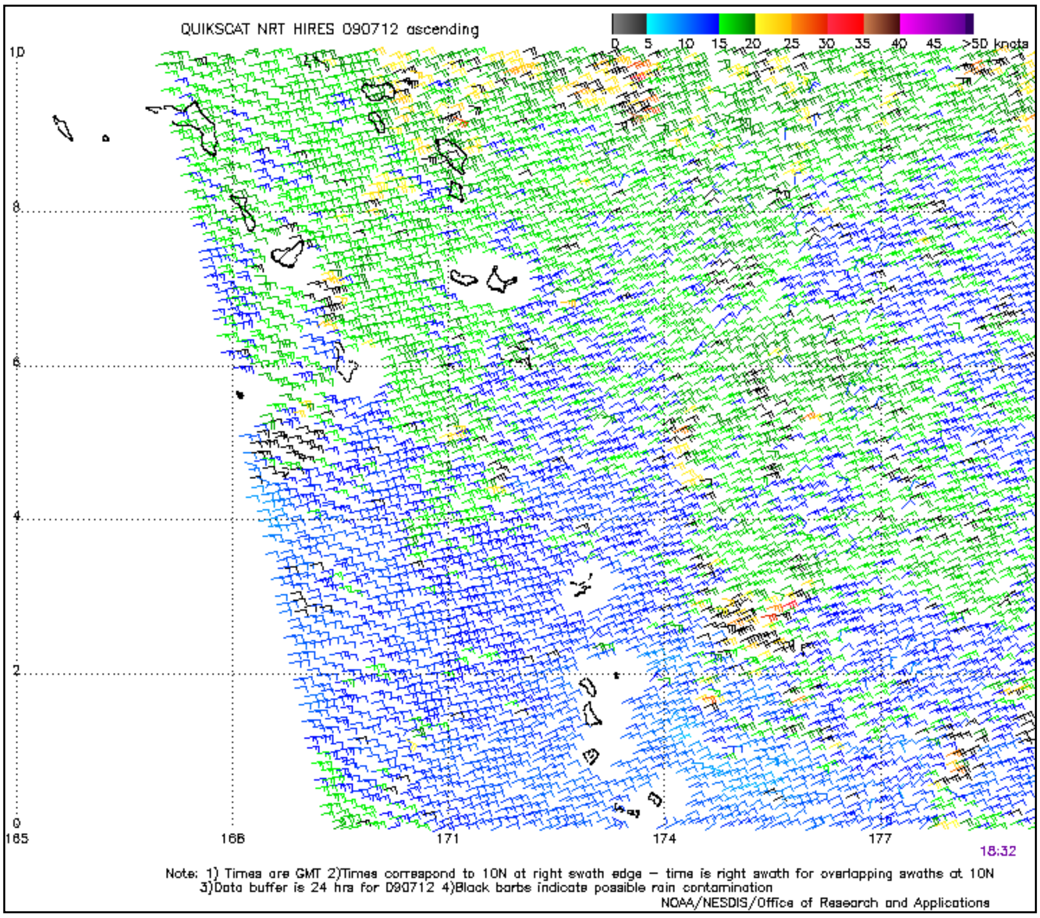
Wind observations are recorded at Bairiki as part of a 3-hourly meteorological reporting programme. These observations have been retrieved from the MetService SYNOP observations database.

Time UTC	Direction DegT	Speed kt	Time UTC	Direction DegT	Speed kt
11-07-2009 00:00	090	10	14-07-2009 00:00	090	11
11-07-2009 03:00	080	6	14-07-2009 03:00	080	11
11-07-2009 06:00	VRB	3	14-07-2009 06:00	070	7
11-07-2009 09:00			14-07-2009 09:00	080	10
11-07-2009 12:00	060	9	14-07-2009 12:00	100	10
11-07-2009 15:00	070	6	14-07-2009 15:00		
11-07-2009 18:00			14-07-2009 18:00	100	18
11-07-2009 21:00	080	8	14-07-2009 21:00	100	19
12-07-2009 00: 00	060	10	15-07-2009 00:00	100	13
12-07-2009 03:00	090	8	15-07-2009 03:00	080	12
12-07-2009 06:00	070	6	15-07-2009 06:00	080	9
12-07-2009 09:00	070	6	15-07-2009 09:00	070	10
12-07-2009 12:00	070	12	15-07-2009 12:00	070	10
12-07-2009 15:00	060	9	15-07-2009 15:00		
12-07-2009 18:00	060	10	15-07-2009 18:00		
12-07-2009 21:00	060	10	15-07-2009 21:00	070	10
13-07-2009 00:00	070	6	16-07-2009 00:00	060	5
13-07-2009 03:00	040	9	16-07-2009 03:00	050	10
13-07-2009 06:00	070	9	16-07-2009 06:00	050	5
13-07-2009 09:00	070	11	16-07-2009 09:00	090	7
13-07-2009 12:00	070	10	16-07-2009 12:00	080	7
13-07-2009 18:00	050	9	16-07-2009 15:00	050	8
13-07-2009 15:00			16-07-2009 18:00	250	7
13-07-2009 21:00	090	10	16-07-2009 21:00	VRB	3
			17-07-2009 00:00	VRB	2

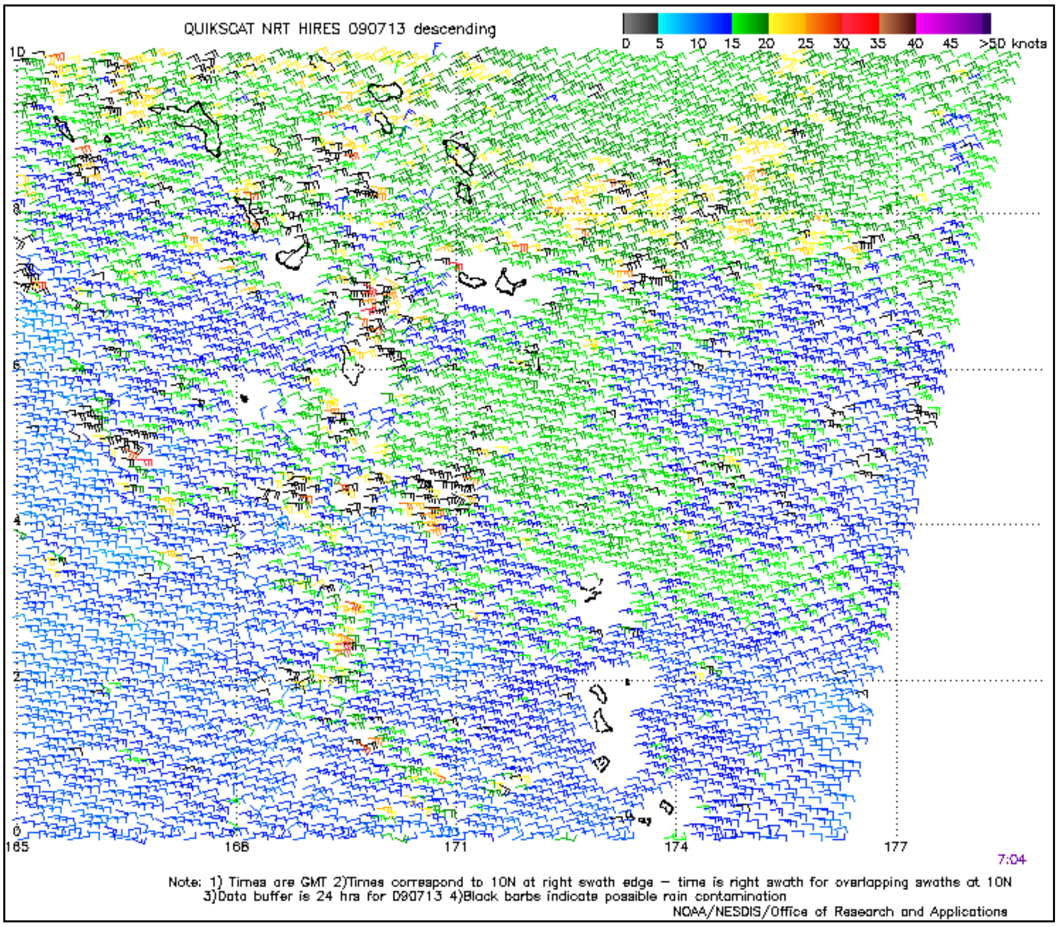
The wind direction is measured in angular degrees clockwise from Geographic North and is the direction the wind is blowing from. It is the mean over the 10 minutes immediately before the observation time, and reported to the nearest 10 angular degrees.
Similarly, the wind speed is an average measured over the 10 minutes immediately before the observation time, and is reported to the nearest whole knot.
There are no meteorological reports from ships within 400 nautical miles of 1°N 173°E between 11 and 16 July 2009.

Satellite observations of ocean wind

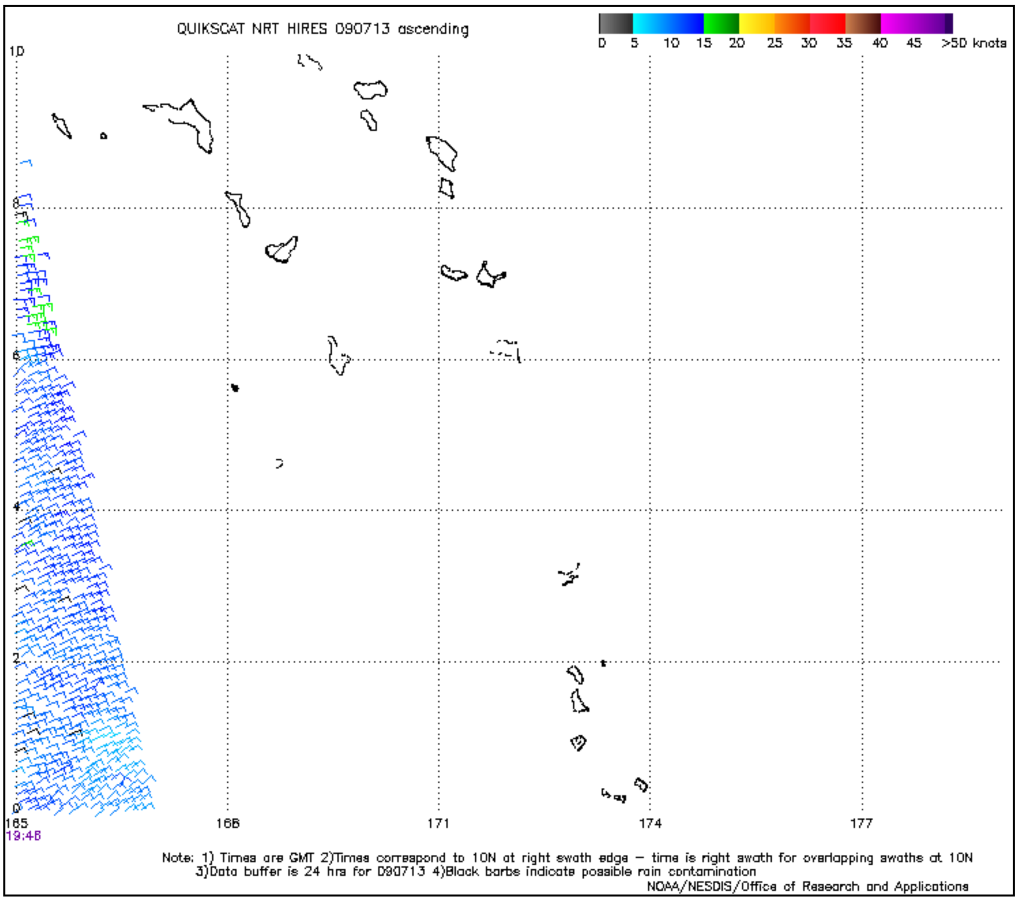
"QuikScat" is a satellite based system for estimating wind speed and direction over the open oceans. The satellite is sun-synchronous polar orbiting which means that it passes overhead any place on the Earth at the same local time, twice every day. The resulting data is made publicly available more or less in real-time on NOAA's Marine Observing Systems web site at http://manati.orbit.nesdis.noaa.gov/hires/. Historical data is available from a archive at http://manati.orbit.nesdis.noaa.gov/cgi-bin/hires_day_qf.pl .
The data is presented in the form of 10 by 15 degree tiles containing latitude and longitude lines, coast line, and coloured symbols to represent wind speed and direction.



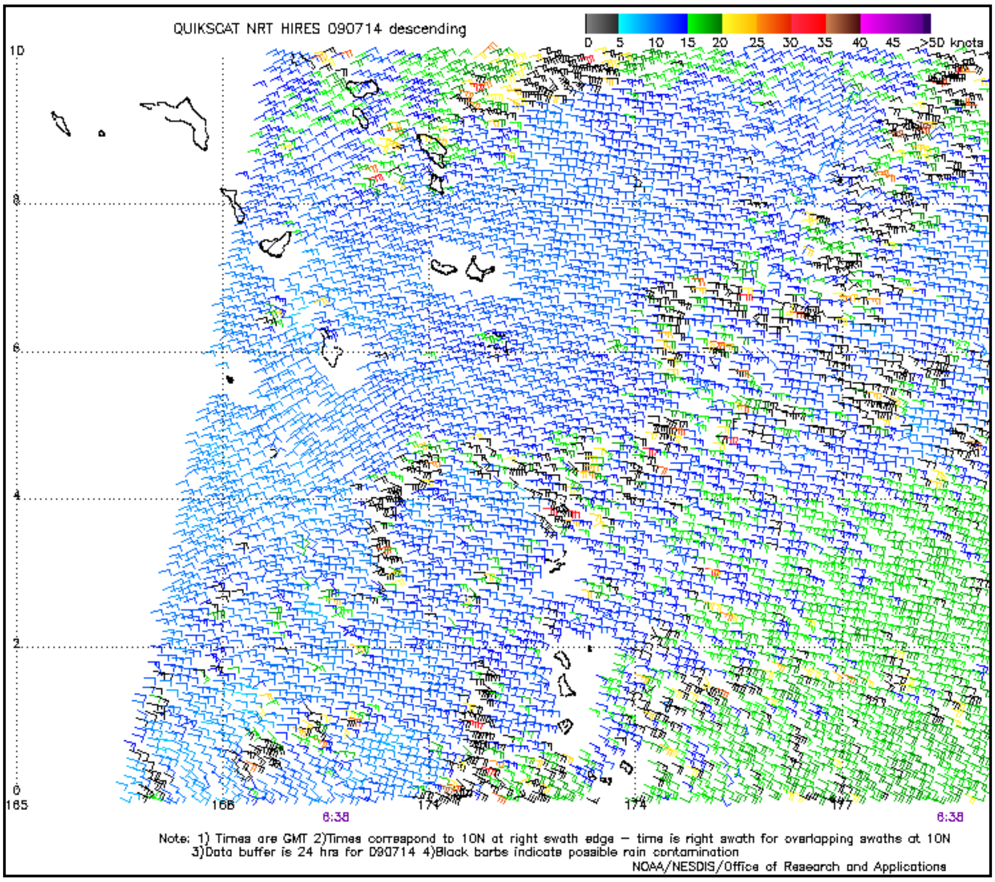
At 1800 UTC 12 July 2009 the wind near 1°N 173°E was about 10 knots from east-northeast.



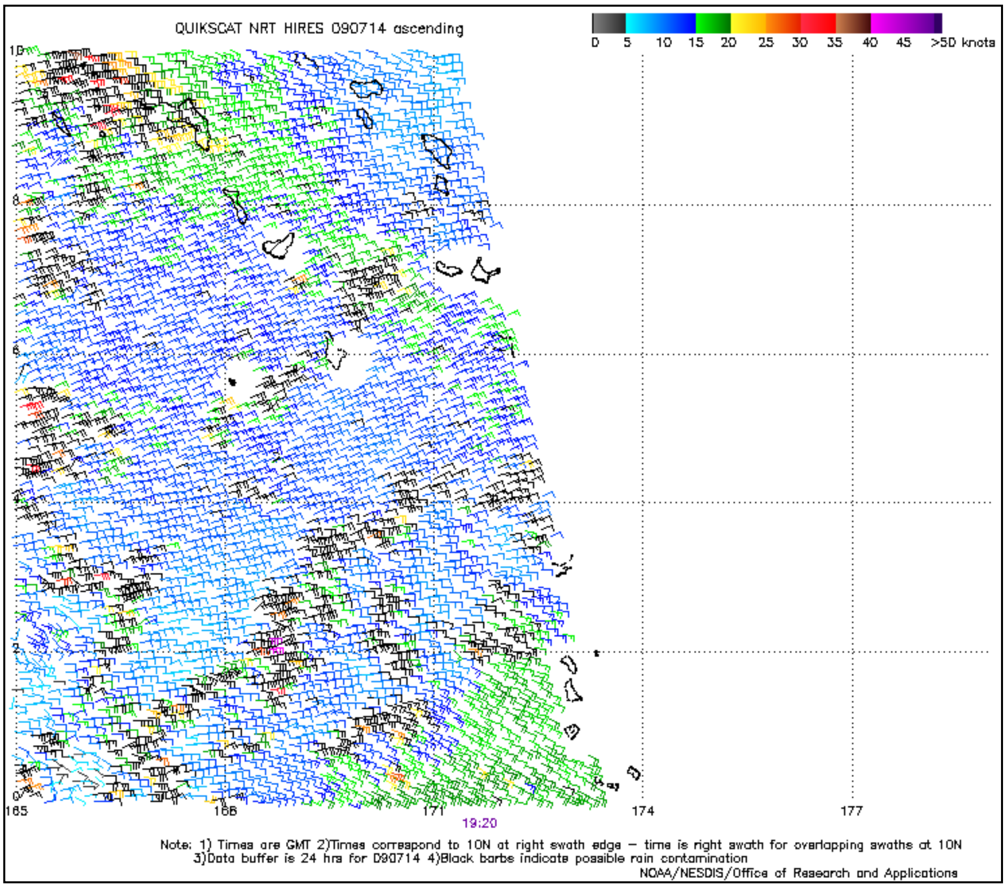
At 0700 UTC 13 July 2009 the wind near 1°N 173°E was about 10 knots from east-northeast.



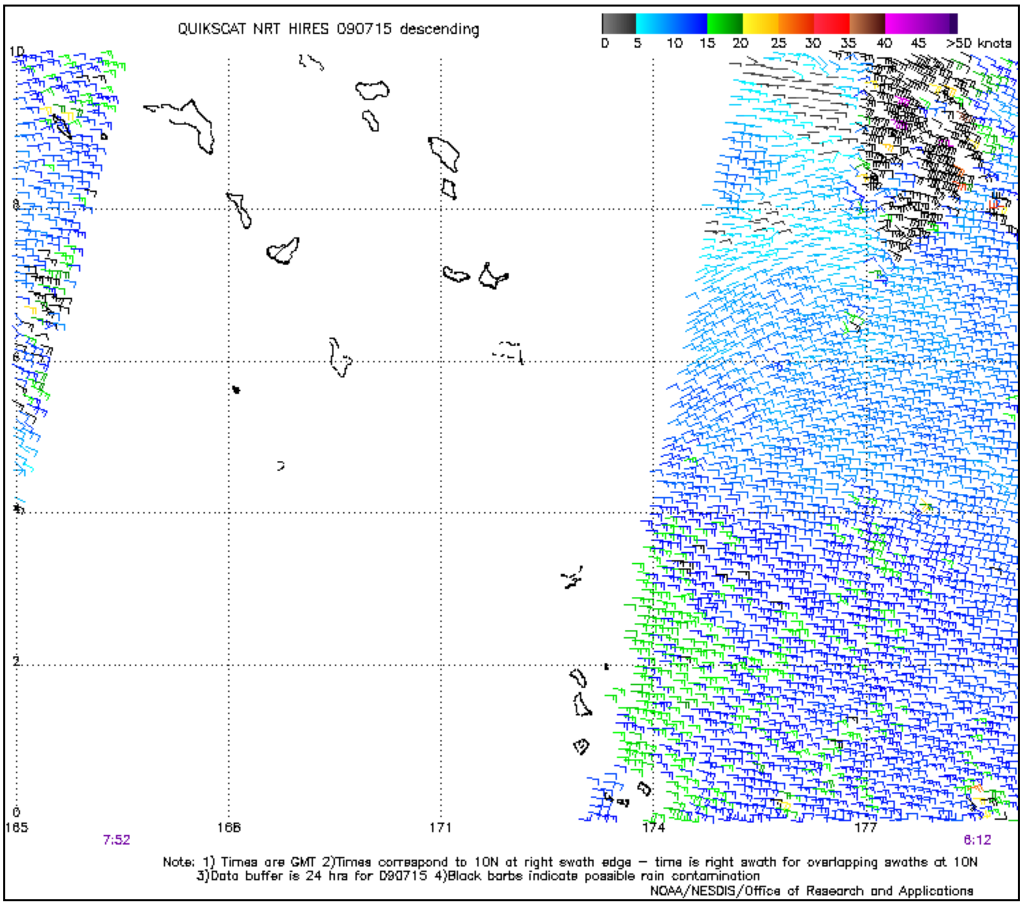
At 1800 UTC 13 July 2009 – not enough data.



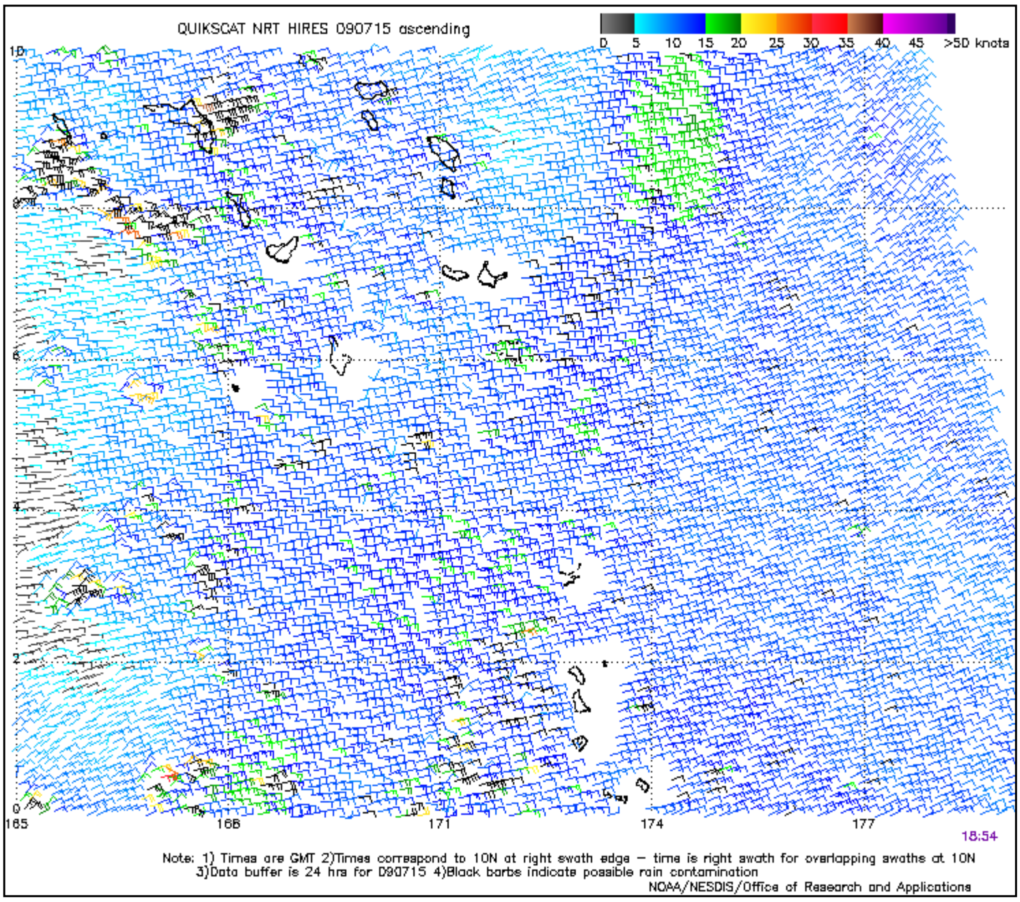
At 0700 UTC 14 July 2009 the wind near 1°N 173°E was 15 knots from east-southeast.



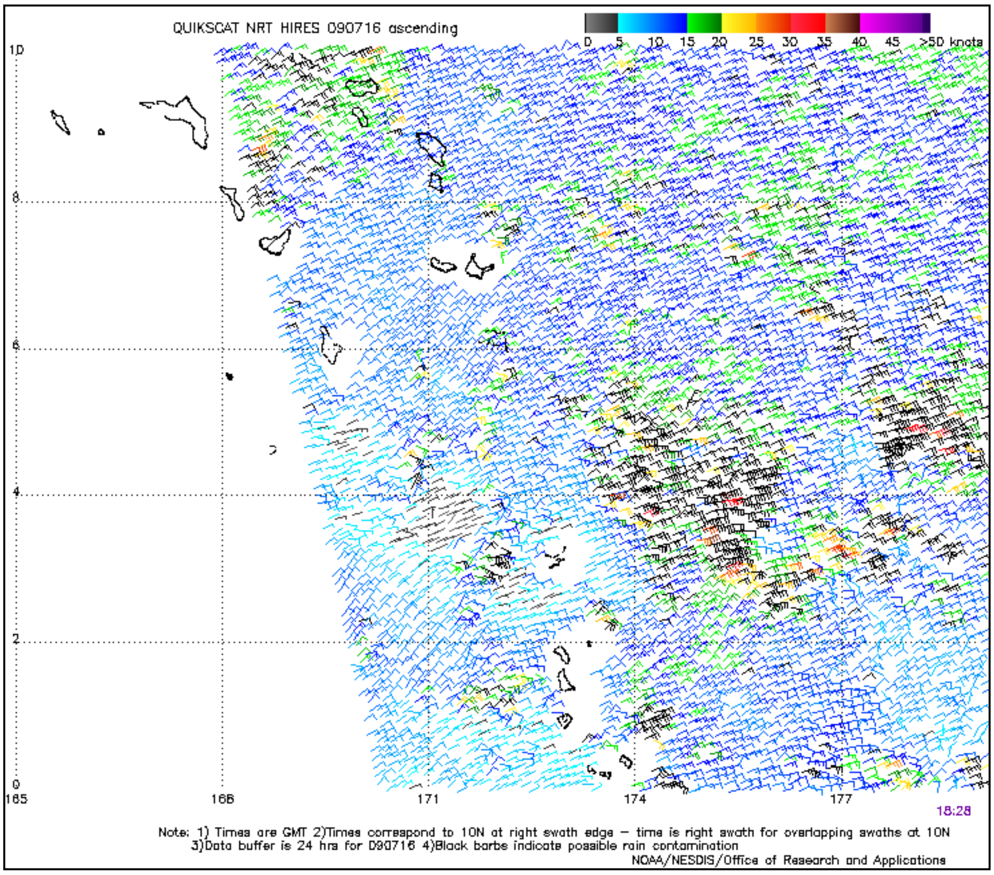
At 1900 UTC 14 July 2009 the wind near 1°N 173°E was 15 to 20 knots from southeast.



At 0600 UTC 15 July 2009 the wind near 1°N 173°E was about 10 knots from the east.



At 1900 UTC 15 July 2009 the wind near 1°N 173°E was about 10 knots from the east
At 0600 UTC 16 July 2009 – no descending pass covering this tile.



At 1800 UTC 16 July 2009 the wind near 1°N 173°E was about 5 knots from northeast.

Assessment of weather and wave conditions between Maiana and Tarawa between 12 and 16 July 2009

The satellite observations of the wind over the ocean near Tarawa are fairly consistent with the observations made at Bairiki. Through this period the wind was from the easterly quarter about 10 knots. There was a short period of stringer wind of about 20 knits from the southeast between about 1200 UTC 14 July and 0300 15 July 2008.

Sea conditions through this period would be described as "smooth" to "slight" in the Beaufort sea scale. The range of significant wave heights was probably 0.6 to 1 metre and occasional waves of 1 to 1.5 metres. During the period of stronger wind between 1200 UTC 14 July and 0300 15 July, the sea would have risen and would be described as "moderate" in the Beaufort scale by about 0000 UTC 15 July, and the significant wave height probably rose to about 2 metres with occasional waves about 2.5 metres around 0000 UTC.

Tidal currents across the relatively shallow ocean between Tarawa and Maiana would have increased wave heights when the tidal flow was in the opposite direction to the wind.

Appendix 2

Stability report

Review of Safety of Vessel

Background

The vessel *Uean Te Raoi II* (*UTR2*) was a 13.7 m outrigger style vessel, that provided a passenger and cargo service in Kiribati. The vessel was launched in May 2009, and after a few months in service the vessel capsized on its 12th voyage, during moderate conditions, with loss of life.

Vessel Design

The available information concerning the vessel consists of:

- Drawings for a similar vessel, the *KIR-5A*
- Offset dimensions recorded by the builder (chine and sheer only)
- A photograph of the vessel on the beach when new (Annex 1)
- Anecdotal reports that the vessel was scaled up from the "Kiribati 5A" design.

The builder's offsets were plotted and provided a reasonably fair hull shape, with an accuracy of say +/- 5 mm. Offsets were not available for the outrigger, and so an approximate version has been assumed based on the photograph and the *KIR-5A* drawings.

It has been assumed that the offsets given are moulded dimension, as is normal with traditional boatbuilding, and are therefore to the outside of the frames (i.e., the inside of the covering plywood). An allowance has been made for the thickness of the reported construction materials of the main hull (32 mm ply bottom and 16 mm ply sides).

The principal dimensions are shown in a table later in this report, and the general outline of the vessel is shown in Figure 1.

Weights and Flotation – Main Hull

The builder reported draught measurements for the vessel loaded with 35 persons at 9 stations, and draught measurements for the vessel unloaded at 2 stations. The resulting waterlines are shown in Figure 1. The loaded draughts would be expected to give a straight waterline, and do so with reasonable accuracy (error margin +/- 15 mm) provided that the reported draught at the station 12m from the transom is taken to be actually at the station 10 m from the transom. This is likely to have been a simple experimental error on the day.

The lightship draughts are also plotted as a straight line between the two points recorded. The weight and flotation data calculated for these waterlines is shown in the table below:

Condition			Light	35 Pax
Length PP		m	13.7	13.7
Draught at FP		mm	374	407
Draught at AP		mm	340	571
Load sinkage FP		mm		33
Load sinkage AP		mm		231
Trim		mm	-34	164
Pitch		deg	-0.142	0.686
LCG	(aft)	m	7.59	8.115
Displacement		t	3.209	5.169
Load weight		t		1.96

Note - Origin is at baseline and extreme bow

The estimated lightship weight for the main hull, based on the available information in photographs, drawings and other records, would be approximately 2.5 – 2.75 t, therefore the recorded weight is somewhat higher than expected. The results above also indicate that the load of 35 pax was around 1.96 t, which implies an average weight of only 56 kg, compared to a more usual average passenger weight of at least 75 kg.

The possible explanations for this inconsistency are:

- Some of the 35 reported passengers were children
- There were actually fewer than 35 passengers
- The vessel had some load aboard when the lightship draughts were recorded.

For example, if the average weight was 70 kg (mix of 35 passengers, adults and children), and the loaded waterline is accurate, then the lightship weight would actually be 2.72 t, which would seem more realistic. For the purposes of this report, a lightship value of 2.75 t has been assumed.

Outrigger

The available information states that the outrigger was 6.7 m long, and from the photograph its general form followed that shown on the *KIR-5A* drawings. An approximate computer model has been constructed, which indicates a displacement of 370 kg, assuming that the waterline was about 40 mm below the top of the painted antifouling line. While there is some uncertainty about this value, the maximum weight that it could realistically be is only around 450 kg.

The offset distance for the outrigger is a critical aspect of the design and stability control of these vessels. It is reported that the lengths of timber used for the cross beams were 5.8 m, and that this gave an offset distance of 4.5 m measured centre to centre of the hulls.

Outrigger Vessels – Stability Control

Outrigger vessels have a main hull of slender proportions and usually this will have only marginal stability, if it is not externally supported. The support is provided by a smaller outrigger hull, usually on the port[4] side. This design originally developed because it was based on available timber (tree trunks), and it also does provide a low drag hull form which is suitable for the modest propulsion powers available from paddlers or wind.

With regard to stability, when the vessel tends to roll to port, the outrigger is forced further into the water and the increasing buoyancy force on the outrigger will then roll the vessel back to upright.

The net weight of the outrigger, as perceived from the main hull via the cross beams, is its total weight minus the buoyancy forces. When the vessel rolls to starboard, the outrigger lifts and the buoyancy forces decrease. There is therefore an increase in the net outrigger weight, and this acts to bring the main hull back to the upright position.

In extreme events the outrigger will be either forced completely under, or will lift completely from the water. After either of these events occur there can be no useful increase in the righting forces provided by the outrigger - once it is airborne its apparent weight can no longer increase, and in fact the lever arm will decrease as the roll of the combined vessel brings the outrigger closer to the main hull. For this vessel, the outrigger will become airborne at a roll angle of about 5 deg.

The stability of the vessel is a combination of the righting moment provided by the outrigger, plus the stability inherent in the main hull. After the outrigger is airborne during a roll to starboard, it is only the small reserves of stability available from the main hull that are preventing a complete capsize.

It can be seen from the above discussion that the proportions of the outrigger, and its relationship to the main hull, are critical aspects of the design of outrigger stabilized vessels.

[4] For reasons to do with right-handedness of the original paddlers.

Factors that Influence Capsize

The following factors will lead to forces that may tend to make an outrigger vessel capsize:

- Wind
- Shifting of load
- Wave action
- Roll momentum.

Winds acting from angles near the beam will causes forces that tend to heel the vessel and, particularly for sailing vessels, these may lead to capsize. It is generally preferred to operate outrigger vessels with the outrigger to windward[5], although this option is not always available when the vessel is motor driven and providing a service on a specific route.

With the outrigger to windward it is not unusual to add extra ballast, such as sandbags or persons, on the outrigger or cross beams to improve stability. Reports indicate that on similar vessels the weight of both passengers and crew had been used at times on the area decked across the forward cross beams. This practice was reviewed after a structural failure of the cross beams on a particular vessel, and on the vessel *UTR2* only crew, and not passengers, were permitted to be used as ballast weight. The structural integrity of the cross beams on larger outrigger vessels is a recognized issue, but if they are unable to accept adequate ballast weight then the need for stability enhancement should logically be addressed in some other manner.

If the loads carried within the main hull are offset to leeward, then they can also cause a significant capsizing force that exacerbates the effect of the wind. This effect may be caused during initial loading,[6] but is more likely to be caused by cargo and/or passengers shifting to the leeward side during roll events. After an initial shift, the passengers and/or cargo may be unable to return to uniform loading locations prior to the next, and usually larger, roll event.

Wave action and roll momentum also provide forces that can tend to capsize the vessel, but usually only after its basic safety has already been compromised by poor design or the other loading factors discussed above. The analysis of wave effects on stability is complex, due to the large number of factors involved. These include wave height, length, speed[7] and steepness, the relative angles involved, and the natural roll period of the vessel and its dynamic response to wave action.

In simple terms, a wave induced capsize may involve the following sequence. Waves that are short and steep approach the vessel from near the beam. A wave crest lifts the outrigger at about the same time that the main hull is in a trough, so the whole vessel is heeled to a certain angle to leeward. If the heel angle is more than the capsize angle, then the vessel is likely to continue to roll in the leeward direction, and capsize.

The outrigger offset dimension has been discussed above, because increased offset provides greater righting forces. It is also important in relation to wave induced roll, as a greater outrigger offset distance means that, for a given wave height crest to trough, the induced heel angle will be reduced. For a vessel with the reported dimensions, a difference in height of 1 m between the outrigger and the main hull will cause a roll angle of about 14 deg.

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[5] The reason for this is to prevent a sudden loss of control if the outrigger to leeward is forced under. The risk of having the outrigger to windward, and possible airborne, is considered more manageable.
[6] This can be difficult to detect, as these vessels have a high GM and will not list appreciably with an offset load.
[7] There are established relationships between many of these factors, but these apply only in deep water, and not in the relatively shallow water environments where outrigger vessels often operate.

Acceptable Stability Criteria

There is no known criteria that set an acceptable stability limit for outrigger vessels. Some maritime regulations, such as NZ Maritime Rule 40A, do have criteria for multihull vessels but it is quite clear from the technical content that many aspects are intended for catamaran vessels with identical hulls.

In general, outrigger vessels are based on designs that have been well established by traditional use, and the safety aspects have been verified by a combination of evolution and trial and error.

After considering the general intent of various stability criteria for other vessel types, the benchmark to be used for the purposes of this report is summarized as follows.

After the heeling forces have been met, the stability reserves of the vessel available to resist capsize should be at least 25% of the total stability reserves of the vessel up to point of capsize[8].

This broadly follows one, out of a total of 9, of the points that make up the Rule 40A criteria for passenger vessels, and represents a relaxed criteria that should be easily achievable. Taken by itself, this criteria would lead to a vessel that was somewhat less safe than would normally be acceptable in a country such as New Zealand.

Sample Loadings

The stability of the *UTR2* vessel has been assessed against the stated criteria, and in relation to the capsizing forces caused by beam winds and offset loading. As discussed above, the effects of wave action are much more complicated and cannot be easily included in an analysis of this type.

A number of example operating conditions were reviewed, and it was assumed that all passengers were carried sitting on the main deck, and that the average passenger weight was 75 kg, and that all cargo was carried below the level of the deck. The results are summarized in the table below:

Condition		A	B	C	D	E	F
Passengers	No	30	30	30	45	45	45
Cargo	kg	800	800	800	1000	1000	1000
Displacement	t	5.8	5.8	5.8	7.13	7.13	7.13
Wind Speed	kts	30	30	35	30	30	35
Load offset	m	0	0.1	0.1	0	0.1	0.1
Reserve Stability		2.41	1.19	0.87	1.33	0.41	0.32
Total Stability		3.85	3.38	3.21	2.20	1.67	1.58
Stability Ratio		62.6%	35.3%	27.1%	60.3%	24.7%	20.3%
Capsize angle	deg	24.0	19.0	17.0	20.0	13.0	12.0

Note: "Stability" is measured as the area under the righting and heeling arm curves.
Reserve stability is area between heeling and righting arms
Total stability is the area under the righting arm, to the capsize angle

For example, Condition C represents a load of 30 passengers and 800 kg cargo, all offset by an average of 100 mm to leeward, and with a 35 kt beam wind. The vessel has a 27% stability reserve, and so just meets the nominated criteria. If the load is increased to 45 passengers and 1000 kg of cargo, (conditions E & F) then it has stability reserves of under 25% and is at risk of capsize. In all cases any wave action present would further reduce the stability reserves.

The placing of crew on the cross beams to provide ballast weight would improve the stability characteristics discussed above. As a general guide, a 75 kg person placed near the outrigger end of the cross beams would improve the stability characteristics by about 15%.

[8] Alternatively, this can be expressed as "the area above the heeling arm curve, up to the righting arm curve, must be at least 25% of the total area under the righting arm curve up to the capsize angle".

The KIR series

The subject vessel is a modernized version of a traditional outrigger canoe. A series of designs for such vessels were prepared by a naval architect Oyvind Gulbrandsen, under contract to the Food and Agricultural Organisation (FAO) of the United Nations. The intention was that these designs would assist developing countries to build boats using traditional methods, and thereby enhance local transport and fishing industries. A series of designs, labelled KIR-1 to *KIR-5A*, were prepared and many vessels were built and used in Kiribati and other Pacific countries, with favourable results reported in papers[9] from 1984 onboard. The largest of these vessels was the *KIR-5A*, of length 11.7 m, and the arrangement drawing is attached.

The main parameters of the *UTR2*, compared to the *KIR-5A*, are compared in the following table:

Parameter		KIR 5A	UTR 2	Ratio
Length Overall	m	11.7	13.7	17.1%
Hull Beam	m	1.42	1.78	25.4%
Hull Depth	m	0.87	1.15	32.2%
Outrigger Length	m	5.95	6.7	12.6%
Outrigger Offset	m	3.5	4.5	28.6%
Light Displacement	kg	900	2750	205.6%
Estimated Max Load	kg	1600	4000	150.0%

It can seen that the *UTR2* is a larger vessel in all dimensions, by typically 25%. As a result, its lightship displacement is twice that of the *KIR-5A*[10].

The proportionate increase in the outrigger length is less than the other ratios, which suggests that its weight may also have been less than the value that would have been achieved with a uniform scaling up of the design.

An examination of the *KIR-5A* drawings, in comparison to the photo of the *UTR2*, highlights additional differences between the vessels. The *KIR-5A* is a rather traditional vessel, with no cabin and passengers/cargo are carried in the main hull.

In the *KIR-5A* drawings comments are made about the possible need for the outriggger to be ballasted when it is to windward, and there is some decking structure on the cross beams to facilitate this. For the *UTR2*, weight on the outrigger was not permitted, and while this decision responded to a structural issue, there is no doubt that it also affected the safe operation of the vessel.

The *UTR2* has a large cabin structure, which will significantly increase the wind forces on the vessel. Cargo is carried within the hull but it is understood that the persons sit above the deck level, and so the centre of gravity of the loaded vessel is likely to be proportionally higher than for the *KIR-5A* design.

In summary, the *UTR2* will be more prone to capsize because:

- The passenger weight is carried higher in the vessel
- The structure exposed to wind is significantly larger
- The use of ballast weight on the cross beams was not permitted
- The outrigger size and weight may have been proportionately smaller.

Taking account of all these points, the relative safety of the *UTR2* vessel is probably less than 60% of that achieved by the *KIR-5A* design. While the *UTR2* may be loosely based on the *KIR-5A* design, the differences are so extensive that it is not realistic to claim that one is simply an extension of the other proven design. The *UTR2* is a fundamentally different vessel, with respect to its layout, load carrying ability, and stability parameters.

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[9] For example, SPC 18th Regional Technical Meeting on Fisheries, 1986.

[10] This result is to be expected, as the ratios for length, beam and depth, when multiplied together, imply a volumetric increase of around 94%.

Capsize of the UTR2

The reports of the capsize event suggest that the vessel was loaded with 55 persons, and operating in conditions thought to be winds of around 10 kts., and waves of over 1 m, with possibly larger and steeper waves in an area where tide opposed wind. It is reported that the outrigger was becoming airborne at times, which indicates that the stability was marginal. After some possible passenger and cargo movement to the leeward side, the vessel capsized.

These reports are entirely consistent with the analysis above, noting that the vessel is very close to capsize whenever the outrigger becomes airborne.

With this loading, and offset at an average of 100 mm to leeward, and 10 kts. of wind, the vessel would have had a reserve of stability against capsize of approximately 38%. It would therefore have met the nominated criteria above. However the capsize angle is only 17 deg, and so a modest amount of wave action from the windward direction would be likely to cause capsize.

Alternatively, if the effects of offset load and wind are ignored, then the vessel has an adequate stability reserve, although the capsize angle is still only 22 degrees. In seas that have an effective wave height of about 1.6 m or more (crest to trough), and acting in a manner where they lift the outrigger by this amount relative to the main hull, it is likely that a complete capsize could occur.

It is probable that the actual capsize was a combination of the factors of wind, wave action, and offset loading. With the reported loading, it is clear that the vessel was vulnerable to capsize in a variety of operating scenarios.

Summary

The vessel *Uean Te Raoi II* was loosely based on the proven *KIR-5A* design, but with some significant variations. Most dimensions were increased by about 25%, which resulted in a vessel of almost twice the volume of the original design.

The layout of the vessel was changed, resulting in a cabin structure that caused more wind resistance, and with the passengers being carried relatively higher in the vessel. These factors contributed to a decrease in the vessel’s safety, with regard to its resistance to capsize.

An earlier decision not to allow weight to be carried on the cross beams addressed a structural issue, but prevented the traditional method of stability improvement used on this type of vessel.

The resulting vessel did not provide an acceptable level of safety in anything beyond sheltered waters operation. It was at significant risk of capsize with loads of over 30 persons, combined with wind conditions of over 30 kts, or in beam sea conditions of over about 1.5 m.

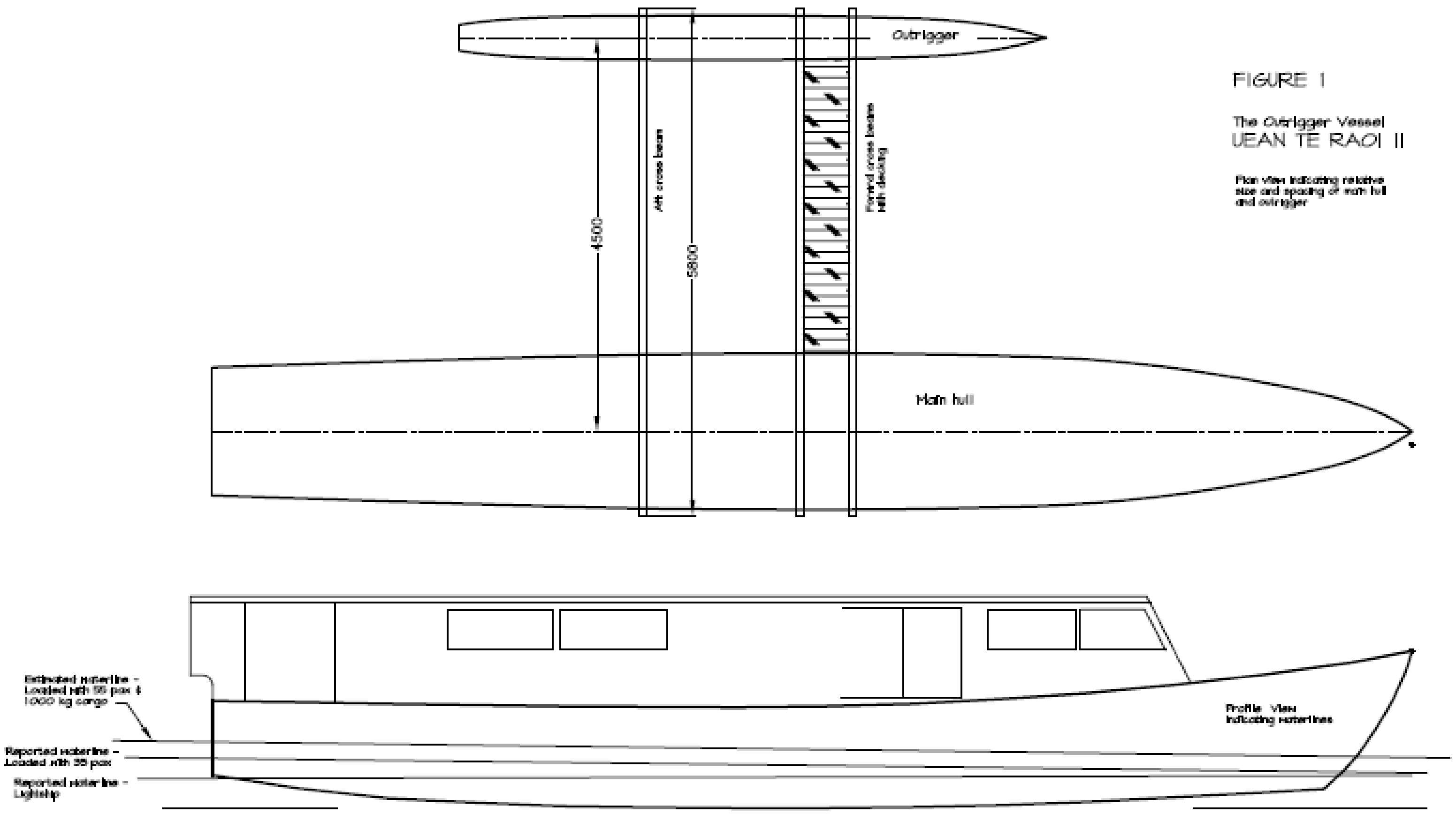
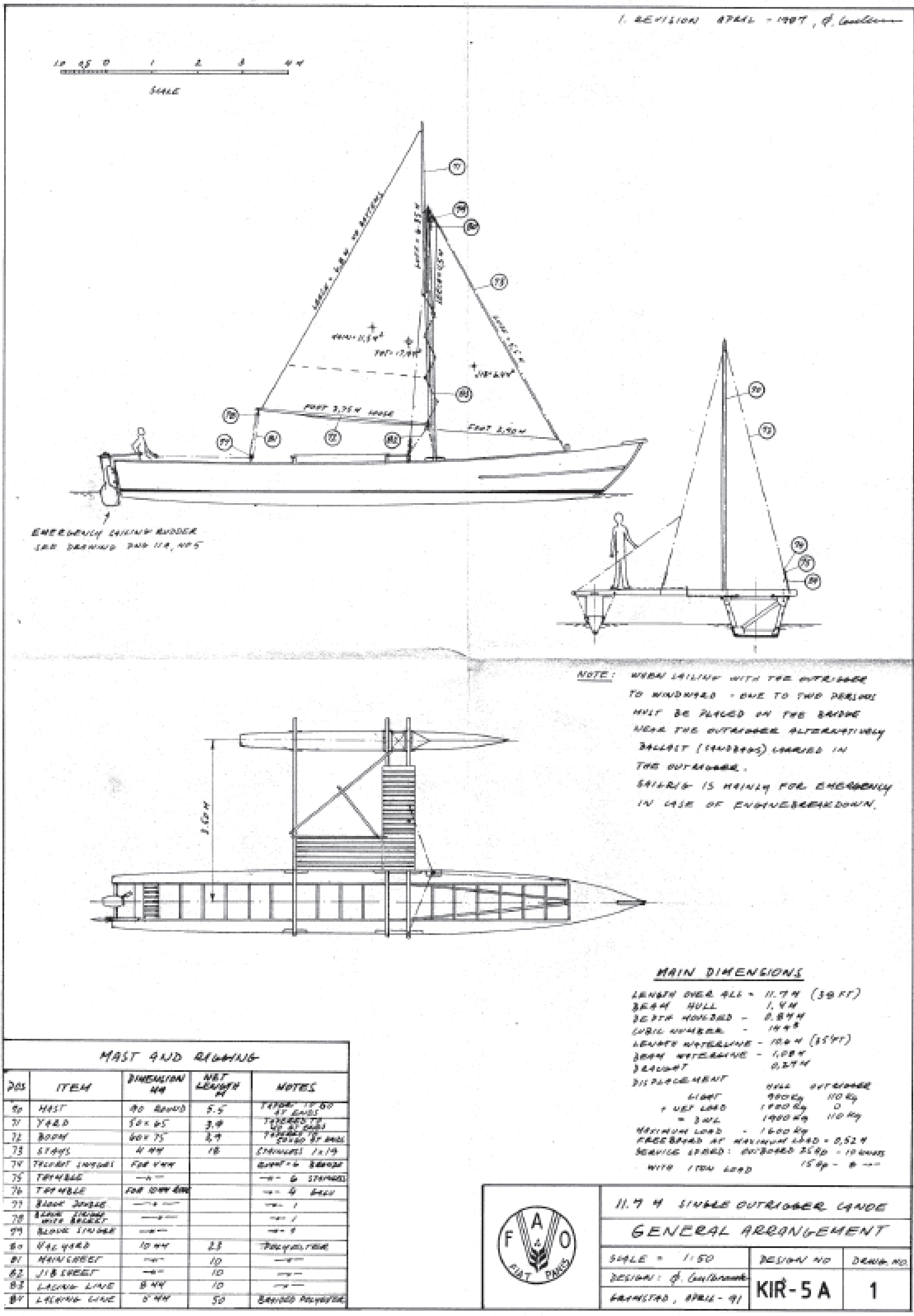


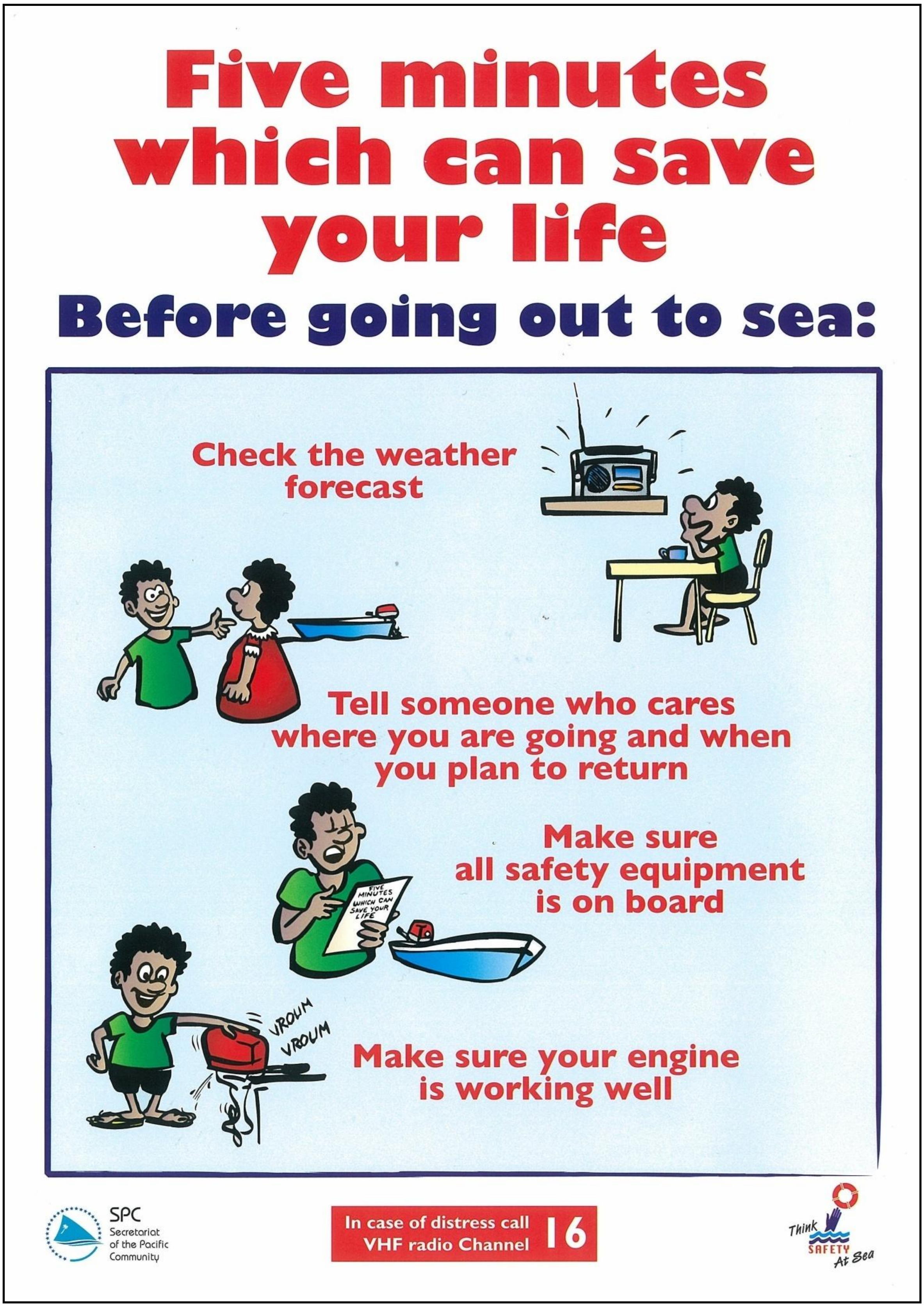
FIGURE 1
The Outrigger Vessel
UEAN TE RAOI II
Plan view indicating relative size and spacing of main hull and outrigger
Outrigger
Forward cross beams with decking
Aft cross beam
4500
5800
Main hull
Profile View indicating waterlines
Estimated waterline - Loaded with 55 pax & 1000 kg cargo
Reported waterline - Loaded with 35 pax
Reported waterline - Lightship



1. REVISION APRIL - 1997
SCALE
EMERGENCY SAILING RUDDER SEE DRAWING DWG 114, NO 5
NOTE: WHEN SAILING WITH THE OUTRIGGER TO WINDWARD - ONE TO TWO PERSONS MUST BE PLACED ON THE BRIDGE NEAR THE OUTRIGGER ALTERNATIVELY BALLAST (SANDBAGS) CARRIED IN THE OUTRIGGER.
SAILING IS MAINLY FOR EMERGENCY IN CASE OF ENGINEBREAKDOWN.
MAIN DIMENSIONS
LENGTH OVER ALL = 11.7 M (38 FT)
BEAM HULL 1.4 M
DEPTH MOULDED - 0.84 M
CUBIC NUMBER - 14 M³
LENGTH WATERLINE - 10.6 M (35 FT)
BEAM WATERLINE - 1.08 M
DRAUGHT 0.27 M
DISPLACEMENT
HULL OUTRIGGER
LIGHT 900 Kg 110 Kg
+ NET LOAD 1000 Kg 0
= DWL 1900 Kg 110 Kg
MAXIMUM LOAD - 1600 Kg
FREEBOARD AT MAXIMUM LOAD = 0.52 M
SERVICE SPEED: OUTBOARD 25 Hp - 10 KNOTS
WITH 1 TON LOAD 15 Hp - 8
MAST AND RIGGING
POS / ITEM / DIMENSION MM / NET LENGTH M / NOTES
70 MAST 90 ROUND 5.5
71 YARD 50 x 65 3.4
72 BOOM 60 x 75 2.9
73 STAYS 4 MM 18 STAINLESS 1x19
74 THIMBLE
75 THIMBLE
76 THIMBLE
77 BLOCK DOUBLE
78 BLOCK SINGLE WITH BECKET
79 BLOCK SINGLE
80 HALYARD 10 MM 23 POLYESTER
81 MAINSHEET 10
82 JIB SHEET 10
83 LASHING LINE 8 MM 10
84 LASHING LINE 5 MM 50 BRAIDED POLYESTER
F A O FIAT PANIS
11.7 M SINGLE OUTRIGGER CANOE
GENERAL ARRANGEMENT
SCALE = 1:50
DESIGN NO
DRWG. NO.
GRIMSTAD, APRIL - 91
KIR - 5 A
1

Appendix 3

Small boat safety checklist




SMALL BOAT
SAFETY CHECKLIST
SPARE FUEL
ENGINE TOOLS AND SPARES
ANCHOR AND ROPE
SEA ANCHOR
ALTERNATIVE PROPULSION
COMPASS
FLARES
MIRROR
SIGNALLING DEVICE
FLOTATION DEVICE
WATER CONTAINER
WATER
WATER
FOOD
FIRST AID KIT
KNIFE
BAILING DEVICE
SHADE
SPC
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Produced by the Nearshore Fisheries Development and Training Section.
Think SAFETY At Sea

Works Cited

Government of Kiribati. (2007). Working Practices and Procedures. In G. o. Kiribati, *Quality Manual* (p. Para 2.15). unpublished.

Government of New Zealand. (2000). *Maritime Rules, Part 40A, design, Construction and Equipment Passenger Ships which are not SOLAS ships.* Wellington: Maritime Safety Authority of New Zealand.

Government of the Reublic of Kiribati. (2009, July 7). *Kiribati Sessional Legislation* . Retrieved December 8, 2009, from Pacific Islands Legal Information Institute: http://www.paclii.org/ki/legis/num_act

IMO & ICAO. (2007). *International Aeronautical and Marine Search and Rescue Manual.* London/Montreal: IMO & ICAO.

International Maritime Organization. (1979). *Maritime Safety Conventions*. Retrieved November 23, 2009, from International Maritime Organization: http://www.imo.org/

New Zealand Meteorological Service (MetService). (2009). *Weather and sea conditions near 1 North 173 East between 13 and 16 July 2009 UTC.*

Stronach & Associates. (2009). *Review of Safety of Vessel, Uean Te Raoi II.*

United Nations. (2009, April 8). *Oceans and Law of the Sea, Division for Ocean affairs and the Law of the Sea*. Retrieved November 24, 2009, from United Nations Organization: http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm