

## **AIRCRAFT ACCIDENT REPORT 15/8/79**

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### **FINAL REPORT ON THE ACCIDENT INVOLVING VIKING DHC-2 BEAVER FLOATPLANE, DQ-TAM AT NEWTOWN, NADI, FIJI ON THE 24 DECEMBER 2017**

This investigation was carried out in accordance with the Civil Aviation (Investigation of Accidents) Regulations and the Standards of Annex 13 to the Convention on International Civil Aviation.

DEPARTMENT OF CIVIL AVIATION













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## **AIRCRAFT ACCIDENT REPORT 15/8/79**

OWNER:-	Turtle Airways Ltd
OPERATOR:-	Turtle Airways Ltd
AIRCRAFT TYPE:-	Viking DHC-2 Beaver floatplane, serial number 313
NATIONALITY:-	Fiji
REGISTRATION:-	DQ-TAM
PLACE OF ACCIDENT:-	Off shore from Newtown Beach, Nadi, latitude 17 degrees 45 minutes 35.63 seconds South, longitude 177 degrees 25 minutes 44.01 seconds East or approximately 0.88 of a nautical mile WSW from the Nadi Airport Aerodrome Reference Point.

DATE AND TIME:-	24 December 2017 at approximately 0044 hours UTC (24 December 2017 at approximately 1344 hours local time).
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Times in this report are universal co-ordinated time (UTC) and, for clarity, where appropriate, local time.

When the accident occurred Fiji local time was 13 hours ahead of UTC.



## **INTRODUCTION**

The sole objective of the investigation into the accident involving a DHC-2 floatplane, registration DQ-TAM, is the prevention of accidents, serious incidents and incidents.

It is not the purpose of this investigation to apportion blame or liability.

Fiji as a Contracting State of the Chicago Convention complies with the Standards of ICAO Annex 13 and as such does not and will not make, records and data available for purposes other than accident or incident investigation.

## **SYNOPSIS**

At approximately 0030 hours UTC on the 24 December 2017 (1330 local time on the 24 December 2017) the Pilot boarded five overseas passengers into the Operator's DHC-2 Beaver floatplane, registration DQ-TAM, at their operating Base located near to the residential settlement of Wailoaloa, on the coastline of Nadi Bay. The routing of the public transport flight was to depart from the Base and proceed to Viwa, off-load three passengers, and then continue the flight to Naqalia where the two remaining passengers would disembark.

After giving the passengers the regulatory safety briefing the Pilot then taxied DQ-TAM to the entrance of a tidal waterway flowing from a cul-de-sac behind and the length of, Naisoso Island and finally, into Nadi Bay. The Pilot's intention was to conduct the takeoff in the smooth waters of the waterway entrance and have DQ-TAM airborne by the time the rough waters of Nadi Bay were reached.

In the vicinity of the entrance he then began his takeoff run towards the South West with the Westerly wind on his right hand side. DQ-TAM was still on the float "steps" when the rough waters were encountered and the Pilot lowered more flap hoping that DQ-TAM would bounce into the air as had happened on previous takeoffs. At one point during the latter stages of the takeoff run DQ-TAM yawed sharply to the left but the Pilot managed to control this however, a second sharp left yaw occurred and he sensed the floatplane was skidding sideways through the water. It then came to a stop.

Following a radio query from the Nadi Airport Control Tower who could not see the aircraft, the Pilot replied that he needed a boat immediately and he repeated this request to the Operator's Base when they contacted him on his mobile telephone to determine why DQ-TAM was still on the water.

The Pilot then informed the passengers that the floatplane was in danger of sinking and ordered them to don their life jackets. After exiting the cabin the passengers then stood on the left hand float with the Pilot but as the rear section of the left hand float was observed to be deep in the water, the suggestion was made that everybody move to the right hand float, which was done. However, this action did not stabilize DQ-TAM on the water and fearing that it may roll over and sink, which it ultimately did, the Pilot ordered the passengers off the right hand float and into the water. They were later retrieved from the water by rescue boats.

Approximately one hour after the accident occurred Inspectors from the Civil Aviation Authority of Fiji (CAAF, the Fiji aviation Regulator) Air Safety Department (ASD) arrived at the Operator's Base to commence their initial assessment and observe rescue/recovery operations.

By 0200 hours UTC (1500 hours local time) one of the Inspectors noted that only the floats of DQ-TAM remained above the surface of the water and the inverted aircraft was being towed towards the Operator's Base.

Based on the observed damage suffered by DQ-TAM during the preliminary assessment the event was classified as an accident and in accordance with Regulation 12 of the Civil Aviation (Occurrence Reporting and Investigation) Regulations 2009, the Hon. Minister of Civil Aviation subsequently appointed an independent aviation accident investigator, Capt. N. Walding, as Investigator in Charge (I in C) on the 28 February 2018, to carry out an investigation into the causes and circumstances leading up to the accident.

## **1. FACTUAL INFORMATION**

### **1.1 History of the Flight**

- 1.1.1 Before departure from the Operator's Base a load sheet had been prepared by the Flight Operations staff which included the pilot's name, aircraft registration the passenger names, their weights, the weight of the baggage and cargo however, no information was entered into the load sheet concerning the position of the center of gravity and the aircraft all up weight.
- 1.1.2 According to the information entered into the Air Traffic Control movement strip and the Mandatory Occurrence Report (MOR) dated the 24 December 2017 local time, the Pilot contacted the Nadi Airport Control Tower by radio at 0040 hours UTC (1340 hours local time) while DQ-TAM was preparing to taxi from the Base pontoon and requested to depart from the waterway entrance at Naisoso for Viwa with six persons on board. The movement strip states that DQ-TAM was cleared by the Nadi Airport Air Traffic Control from Newtown direct to Viwa, under Visual Flight Rules (VFR) at 1,000 feet and with the takeoff run commencing at 0042 hours UTC (1342 hours local time).
- 1.1.3 After a few seconds DQ-TAM was observed by the Air Traffic Controller to be descending towards the water and he asked the Pilot by radio if the ops were normal and the Pilot responded that they had a problem. When asked by the Controller if he needed assistance the Pilot replied "yes".
- 1.1.4 The Air Traffic Controller then requested the Nadi Airport Rescue Fire Service (RFS) to launch their zodiac rescue craft from the satellite base located beside the Operator's Base hangar and at 0044 hours UTC (1344 hours local time) requested that an aircraft, which was carrying out circuit training at the time, fly over DQ-TAM and report what had happened. Once over DQ-TAM the aircraft reported that DQ-TAM was sinking in the water and the passengers standing on its floats. On receiving this information the Air Traffic Controller then pressed the button of the airport crash alarm to activate a full emergency response.



## **1.2 Injuries to Persons**

- 1.2.1 The persons on board DQ-TAM did not suffer from any injuries as a result of this accident;

<u>Injuries</u>	<u>Crew</u>	<u>Passengers</u>	<u>Others</u>
Fatal	0	0	0
Serious	0	0	0
None	1	5	0

## **1.3 Damage to the Aircraft**

- 1.3.1 Considerable damage was done to the left wing tip aluminium fairing and a major portion of the fairing undersurface has a longitudinal concave shape with a section of the outer edge (including the port navigation light) forced upwards above the upper wing surface. The single forward left hand main wing attachment bracket (secures the wing to the fuselage) had failed and found to be in two pieces although the wing securing bolt remained intact and secured in one piece of the bracket.
- 1.3.2 The forward right hand float/fuselage attachment strut bracket had separated at the fuselage and one blade of the 2 bladed propeller was found to be bent an estimated 20 degrees rearward, a length estimated at 5 inches from the tip.  
DQ-TAM suffered from further and considerable damage during the recovery process from the Nadi Bay seabed and being placed in an open storage area at the Lautoka Wharf.

## **1.4 Other Damage**

- 1.4.1 The only other damage caused by this accident was the immersion of the passengers personal affects and electronic equipment in the sea water for an extended period of time until the recovery of DQ-TAM from the seabed was completed.

## **1.5 Personnel Information**

- 1.5.1 Pilot in Command: Canadian national, male, 60 years of age.
- Licence: Fiji Commercial Pilot Licence (Aeroplanes), number 2001963A and valid until 12 April 2018.
- Aeroplane Type Ratings: DHC-2.
- Medical Certificate: Class one, valid until 28 September 2018. Under the headings "Conditions, Restrictions or Endorsements Applicable" of the medical certificate a statement was included which required the licence holder to wear correcting lenses (spectacles) to meet the necessary visual requirements at all distances. It was also necessary that the licence holder carry a spare pair of correcting spectacles when exercising the privileges of the licence.

Total flying experience: According to the flight particulars entered into his logbook up to and including the 24 December 2017, the Pilot had recorded a total flying experience of 12,663.7 hours of which 11,115.0 hours were pilot in command. In addition to his CAAF application for a Fiji validation of his Canadian Commercial Pilot's licence, the Pilot also included a copy of his logbook page, dated the 5 October 2016, which included the DHC-2 type rating and a total of 2,267.8 hours pilot in command on float equipped aircraft.

- 1.5.2 According to the documents held on his company licencing file the Pilot satisfactorily completed a DHC-2 Air Navigation Regulation (ANR) 45 six monthly Base check on the 20 October 2017 and the thirteenth monthly Line check on the 20 April 2017 both of which were valid at the time of the accident.
- 1.5.3 There is no evidence on his company licencing file confirming that the Pilot, since commencing employment with the Operator, had satisfactorily completed a Dangerous Goods Awareness course acceptable to the Regulator. Dangerous Goods Awareness requirements for pilots are discussed in the CAAF Aeronautical Information Circular (AIC), number 08/05.
- 1.5.4 There is no evidence on his company licencing file confirming that the Pilot, since commencing employment with the Operator, had satisfactorily completed a Crew Resource Management (CRM) course acceptable to the Regulator. CRM requirements for pilots are discussed in the CAAF AIC, number 03/13.
- 1.5.5 Evidence on his company licencing file states that the pilot had completed the thirteenth month ANR 45 Dry Drills Emergency Procedures training on the 22 September 2016 and completed the written examination on the 6 April 2017 however, the Operator did not provide the Pilot with a certificate stating that he had satisfactorily completed the Emergency Procedures training, the mark which he obtained at the completion of the examination and the name of the CAAF approved Emergency Procedures Instructor.
- 1.5.6 The Operations Specifications (AOC # 003/30) issued by the Regulator on the 10 July 2017 lists the Pilot as holding the post of Acting Chief Pilot for the Operator and he still retained this post when the accident occurred.
- 1.5.7 The last entry in the Pilot's Flight and Duty records is dated the 14 March 2018 and at some time following this date the Pilot departed from Fiji on pre-arranged leave overseas with the plan that he return to flying duties with the Operator upon his return at a later date. This arrangement is supported by a letter from the Operator to the Regulator and dated the 14 May 2018, which states that the Pilot would be absent from the 7 May to the 7 June 2018 on annual leave. Unfortunately and for reasons only known to himself, the Pilot did not return to Fiji and so the investigation has had to proceed without any further input from the Pilot. Although the investigation was later given the Pilot's email address by the Operator and contact established through his spouse the Pilot has not, to date, responded to any queries concerning the accident.

## 1.6 Aircraft Information

### 1.6.1 Leading particulars

Aircraft Type:	Viking DHC-2 MK1 floatplane
Aircraft serial No:	1433
Aircraft year of manufacture:	1960
Engine:	1 x Pratt and Whitney radial piston engine which had accumulated as at the end of the 22 December 2017, a total time of 849 hours 58 minutes since overhaul and was installed in DQ-TAM on the 8 December 2017. The Operator's Maintenance Schedule Programme states that the recommended engine overhaul or replacement should be done after 1,600 hours of operation.
Propeller:	1 x Hamilton Standard two bladed variable pitch propeller which had accumulated as at the end of 22 December 2017, a total time of 1,259 hours 40 minutes. The Operator's Maintenance Schedule Programme states that the recommended propeller overhaul or replacement should be done after 1,600 hours of operation.

Constructed by De Havilland of Canada (manufacturer's previous name) and certified in Canada, DQ-TAM had accumulated a total of 15,667 hours 16 minutes airframe time in service at the end of the 22 December 2017.

The aircraft had been issued with a Certificate of Airworthiness by the Regulator, number 313, in the Transport Category (Passenger).

The Certificate of Airworthiness was valid until the 16 August 2018.

### 1.6.2 Certificate of Maintenance

DQ-TAM held a valid Certificate of Maintenance, Number 028, issued by the Operator on the 23 November 2017 with an expiry date of 23 March 2018.

### 1.6.3 Radio Installation

The most recent Certificate of Approval of Aircraft Radio Installation for DQ-TAM was issued by the Regulator on the 5 July 2017 with an associated Aircraft Station licence expiry date of the 16 August 2018.

#### 1.6.4 Technical Log

The Technical Log pages applicable to the 23 - 24 December 2017 and the Technical Log pad were not available due to DQ-TAM becoming submerged in Nadi Bay for a number of days with the documentation remaining on board. Technical Log records are only available up to and including, the 22 December 2017.

#### 1.6.5 Certificate of Release To Service

The Certificate of Release To Service (CRS), number 0072, and applicable for DQ-TAM (categories aircraft, engine) had been signed by the certifying engineer on the 13 October 2017 and with a validity period of 100 hours. The last 100 hour inspection was completed in accordance with the approved Maintenance Schedule, AMS/CAAFWD/ 301 at 15,580 hours 27 minutes on the 13 October 2017 and the next 100 hour inspection was due at 15,680 hours 27 minutes airframe time.

#### 1.6.6 Maintenance Statement

The Maintenance Statement, number 0072, also required that the engine oil be changed after 50 hours of operation which would be due at 15,630 hours 27 minutes airframe time.

### 1.7 Meteorological Information

- 1.7.1 The surface synoptic weather chart issued by the Fiji Meteorology Service and effective at 2400 hours UTC on the 23 December 2017 (1300 hours local time on the 24 December 2017) 44 minutes before the accident occurred, depicted sunny weather conditions over Fiji with a Northerly airflow at a speed of 25 knots.

These conditions were driven by a low pressure system known as TD04F (Tropical Depression 04F) which was centered at a latitude of approximately 21 degrees South and longitude of 176 degrees East or at an estimated position of 180 nautical miles South of Viti Levu. TD04F was the result of two convergence zones joining to the South of Viti Levu, one originating from the Equatorial region and arcing Southwards and slightly East of Wallis and Futuna islands, the other convergence zone originating from the East and spanning Westwards passing close to Niue and Tonga.

With a high pressure system located over New Zealand, a moderate pressure gradient existed between TD04F and the high pressure system influencing the wind strength of TD04F.

- 1.7.2 The Fiji Meteorology Service satellite photograph taken at 2300 hours UTC on the 23 December 2017 (1200 hours local time on the 24 December 2017) essentially confirmed the weather conditions at Fiji as depicted on the surface synoptic weather chart.

- 1.7.3 The Nadi Airport Terminal Aerodrome Forecast (TAF) issued by the Fiji Meteorology Service for the period 2406/2506 UTC (from 1900 hours on the 24 December to 1900 hours on the 25 December 2017 local time) states as follows, *wind 270 degrees true at 09 knots, visibility more than 10 kilometers, cloud scattered at 2,000 feet, scattered at 4,000 feet, probable 30% tempo (over a one hour period) 2406/2410 (1900 hours to 2300 hours local time) visibility 5,000 meters, showers and rain, cloud broken at 1,500 feet. Probable 30% tempo*



*2502/2506 (1500 hours to 1900 hours local time) visibility 5,000 meters, showers and rain, cloud broken at 1,500 feet.*

- 1.7.4 The Nadi Airport actual weather conditions (METAR) observed by the Fiji Meteorology Service at 240000Z (1300 hours on the 24 December 2017 local time) states as follows, *wind 280 degrees true at 13 knots, visibility more than 10 kilometers, light showers and rain, scattered towering cumulus cloud from 2,000 feet, cloud scattered from 4,500 feet, air temperature 29 degrees C, dewpoint 25 degrees C, air pressure 1004 hectopascals, no significant change.*

## **1.8 Aids to Navigation**

- 1.8.1 Not applicable, the level of flight instrumentation installed within DQ-TAM required that the flight be conducted in accordance with the Visual Flight Rules (VFR).

## **1.9 Communications**

- 1.9.1 The CAAF issued Approval for Radio Installation states that DQ-TAM was fitted with one Very High Frequency (VHF) transceiver for normal air-to-air and air-to-ground communications and the investigation did not reveal any difficulties being experienced by the Pilot in his routine exchanges with the ground stations.

## **1.10 Aerodrome Information**

- 1.10.1 Nadi Bay is situated on the Western side of Viti Levu, Fiji's largest island, with the coastline starting at Vuda Point which is approximately 6.5 nautical miles from Nadi Airport, then arcing slowly from an Easterly direction to a Southerly direction, passing close to Nadi Airport and then arcing slowly towards the West and Denarau which is located approximately 4.25 nautical miles from Nadi Airport. The waters of Nadi Bay extend from the coastline Westwards and out to a number of islands located offshore.
- 1.10.2 Nadi Bay is suitable for floatplane operations as the land mass of Viti Levu gives it a measure of protection from Easterly and Southerly winds, the bay is large and permits takeoffs and landings in any direction. Occasional rock obstacles extending from the seabed are situated within the confines of the bay but these are marked to visually identify their location to pilots.  
The bay however, is vulnerable to winds blowing from the North through to the South West.
- 1.10.3 The Operator's Base is located on the Nadi Bay coastline, close to Nadi Airport, and has the infrastructure to operate and maintain floatplanes, which it has done for a number of decades. Stretching out a short distance seaward from the coastline at the Base is a stone jetty to which a pontoon is moored at the Western end.  
The accident site is located in the waters of Nadi Bay a short distance to the West of this jetty.

## **1.11 Flight Recorders**

- 1.11.1 Not applicable as the all up weight of DQ-TAM does not exceed 5,700 kilograms.

## **1.12 Wreckage and Impact Information**

- 1.12.1 DQ-TAM sank inverted in the waters of Nadi Bay and came to rest on the sandy seabed. Later, using suitable waterborne craft (large self-propelled barge) with a mobile crane, a strop was placed around both the propeller blades with the intention that the crane would slowly raise DQ-TAM, in the vertical position, from the seabed and place it on the barge. Unfortunately, as DQ-TAM neared the surface the engine separated from the airframe due to the heavy weight of the airframe, which then sank back to the seabed. The decision was then made to place the strops around both the floats and raise DQ-TAM in the inverted position to the surface.

Once this was done a high pressure water hose was used to remove a large amount of sand which had accumulated in the cockpit and cabin while the aircraft was resting on the seabed and accordingly, reduce the weight of DQ-TAM and minimize further damage occurring during the recovery operation.

- 1.12.2 DQ-TAM was then slowly raised above the surface with brief pauses from time to time, allowing the water to drain from the floats, interior areas of the fuselage, main wings and tail plane. Further damage occurred to the float struts during the recovery operation and on the upper fuselage skin as DQ-TAM was placed inverted, on the barge.
- 1.12.3 On arrival at the Lautoka Wharf DQ-TAM suffered from further damage during the transfer from the barge to the open storage area nearby.

## **1.13 Medical and Pathological Information**

- 1.13.1 Neither the Pilot nor the five overseas passengers on board DQ-TAM suffered from any injuries as a result of this accident. A doctor and nurse from a clinic next to the Fiji Airports Ltd (FAL) Compound examined the Pilot and passengers at the FAL rescue boat facility next to the Operator's Base ensuring that no injuries had occurred during the aircraft evacuation and being immersed in the water for a short period of time before the boat rescue.

- 1.13.2 Following the accident the Pilot signed a document, dated the 24 December 2017, to voluntarily undergo a medical examination at the clinic next to the FAL Compound to ensure that he was not under the influence of either alcohol or drugs at the time of the accident. The report subsequently issued by the clinic stated that the test results for alcohol and drugs were negative.

- 1.13.3 At the Pilot's last medical examination, completed on the 29 September 2017, the CAAF approved examining doctor signed his Examination Result Slip as meeting the medical standards for the issue of a CAAF Class One medical certificate with the condition that correcting lenses must be worn when the Pilot is exercising the privileges of his Commercial Pilot Licence.

As the Pilot was over 40 years of age and operating single pilot on floatplanes, he qualified for a medical validity period of 6 months.

#### **1.14 Fire**

1.14.1 Fire did not occur following this accident.

#### **1.15 Survival Aspects**

1.15.1 Despite the events which occurred during the takeoff this was a survivable accident for all the occupants of DQ-TAM based on statements from the Pilot, passengers and photographic evidence. Following the early realization of his predicament and immediately aborting the takeoff with DQ-TAM still upright on the water, the Pilot promptly instructed the passengers to don their lifejackets and when the time came to evacuate the cabin, they were adequately prepared. Later, the passengers had to enter the water and through the ongoing supervision and instructions from the Pilot, this was executed without any of the passengers being exposed to a harmful environment which was commendable by the Pilot.

#### **1.16 Tests and Research**

1.16.1 Due to the impact forces suffered by the left main wing and the right float when the accident occurred, it was considered that no additional evidence would be discovered by undergoing additional specialized tests for any of the aircraft components which had separated, and the only research conducted was the research related to the causes of the accident.

#### **1.17 Organizational and Management Information**

1.17.1 Over the years the Operator has recruited a large number of their floatplane pilots from North America (Canada) where this type of operation is very common due to the topography with numerous lakes and inland waterways which exist there. Typically, the lakes are sheltered by the surrounding terrain and so the pilots generally, do not get exposed to conditions which require them to operate in swells or "choppy" waters. The topography and open waters of Fiji however, are different whereby pilots need to acquire the skills to operate safely in conditions that include swells, moderate strength winds and "choppy" waters on a regular basis.

Accordingly, it is important that management have training and monitoring programs in place whereby recently recruited expatriate floatplane pilots can gain open water experience to operate safely in the Fiji environment without being exposed to unnecessary risks.

1.17.2 Compliance at all times with the Regulator approved Flight and Duty Time Scheme by operators is a regulatory requirement and it is incumbent on top management to ensure that their organizations are staffed with a sufficient number of pilots to satisfy this requirement, despite the fluctuations in commercial demands that may occur during the year. Aircraft fleet numbers and the route structure provide a baseline on determining the minimum number of pilots required and using oversight with forward planning for timely intervention, assist in ensuring regulatory compliance with the scheme.

## **1.18 Additional Information**

### **1.18.1 Pilot's Statement**

- 1.18.2 In his statement, dated the 25 December 2017, the Pilot recorded that at approximately 0030 hours UTC (1330 hours local time) on the 24 December 2017 he loaded five passengers into DQ-TAM at the Operator's Base. After giving the passengers the required safety briefing, he then taxied DQ-TAM out in the direction of the river, intending to taxi up the river to take advantage of the smoother water to be found there for takeoff, the Nadi Bay at this time being quite rough. All three previous takeoffs that the Pilot had conducted earlier in the day had involved bouncing from wave top to wave top and he wished to avoid any more unnecessary stress on DQ-TAM.
- 1.18.3 On arriving at the markers indicating the entrance to the river channel the Pilot turned into the river and proceeded up the channel as far as the seashore at the end of runway 27. The Pilot then obtained his clearance from the Control Tower and began the takeoff. He had hoped that DQ-TAM would become airborne while still in the river but the aircraft was still on the float steps when it departed from the river channel and entered the rough seas again.
- 1.18.4 DQ-TAM bounced two or three times from wave to wave, the Pilot then pumped down a bit more flap and still hoped that DQ-TAM would be bounced into the air as had happened on the earlier takeoffs. At one point DQ-TAM yawed sharply to the left but the Pilot managed to control this. Then DQ-TAM yawed again sharply to the left. The Pilot believed that the left float struck the water at this time while the aircraft was in a left yaw and it seemed to skid through the water in a sideways fashion. Then the aircraft came to a stop.
- 1.18.5 The Pilot then immediately sensed, maybe incorrectly, that DQ-TAM was listing to the right. The Control Tower called almost instantly and asked the Pilot if he needed any help and he responded stating that they needed a boat immediately. The Operator then contacted him on his mobile telephone asking what had happened and he answered stating that a boat was needed immediately.
- 1.18.6 The Pilot states that he then informed the passengers that DQ-TAM was in danger of sinking. He then climbed down to the left float, opened the left cabin rear door and ordered the passengers to don their lifejackets. After this was done the Pilot directed the passengers out of the aircraft and join him standing on the left float, three of them on the front of the float ahead of the passenger door and two standing with the Pilot near the passenger door. At this point the rear of the left float was deep in the water and one of the passengers suggested that they all move to the right float. The Pilot jumped into the water and swam around the left float and climbed aboard the right float. Then two of the men crawled under the engine on to the spreader bar and the Pilot helped them on to the right float. The older woman also came over this way.



- 1.18.7 One of the men and the younger woman chose to swim over and the Pilot helped them as best as he could. Switching floats did not seem to make much difference however and it was obvious that DQ-TAM was going to sink. After a few more minutes the Pilot directed everyone off the aircraft fearing it would roll suddenly and drag everyone down with it. Fortunately, the rescue boat was approaching and everyone was only in the water for a few minutes before being rescued.
- 1.18.8 In the final paragraph of his statement the Pilot also mentions that before they transferred to the right float from the left float, the Pilot directed everyone to inflate their lifejackets and it was only after this was done that everyone made the transfer.

## **2     Analysis**

- 2.1 As the five passengers were overseas tourists, four Asian with one European, and their baggage still on board the submerged aircraft, the Government stakeholders involved with the initial investigation agreed that the investigation should start as soon as possible. The Investigator in Charge-Designate was contacted by telephone with this request, to which he agreed, and interviews with all the occupants of DQ-TAM started during the latter afternoon of the 24 December 2017.
- 2.2 The Pilot was interviewed on the 25 December 2017 and he stated that he did not have any concerns about the serviceability status of DQ-TAM or the engine during the takeoff run. All the aircraft systems operated normally and this was his fourth takeoff of the day in DQ-TAM.
- 2.3 The sea surface was moderately rough and the Pilot stated that he was apprehensive about taking off in these conditions although he had no concerns about taking off in the calm river and intending to be airborne by the time DQ-TAM reached the moderately rough waters. He stated that the takeoff was conducted towards the West and mostly into wind. Immediately prior to start-up at the Operator's Base pontoon he estimated the wind as approximately from the West at a steady strength of 12 knots.
- 2.4 When asked about the condition of the floats the Pilot stated that although the floats did leak, they had been pumped dry by staff members prior to start-up at the pontoon. Water would normally be pumped out of both floats after the second landing.
- 2.5 The male European passenger who occupied the front right hand seat next to the Pilot recorded in his statement that at approximately 0020 hours UTC (1320 hours local time) DQ-TAM had been refueled and the pilot, who identified himself to all the passengers, explained the seating arrangements and procedures in the event of an emergency. The Pilot then explained that he would need to carry out a long taxi on the water to the start of the river in order to find smooth water for the takeoff. The taxi lasted for about 10 minutes to the start of the river mouth and then the pilot turned the aircraft around and accelerated down the "runway" which was indicated by buoy markers.

- 2.6** Due to the very choppy seas and onshore winds, the aircraft hit several waves, markedly lurching to the left each time but failing to get airborne. On the final lurch the aircraft yawed sharply to the left and by then it seemed clear to the pilot that there was an emergency situation at hand. The pilot calmly urged the passengers to remain calm, abandon their belongings, don the lifejackets and begin exiting the aircraft. Before these instructions he had radioed to shore asking for a boat to urgently come to their rescue.  
All the aircraft occupants were in the water wearing their inflated lifejackets for approximately 10 – 15 minutes before the boat arrived to pick them up.
- 2.7** During this time the pilot instructed the passengers to hold on to the floats on the left side of the aircraft as long as possible. As the aircraft was gradually sinking, they moved around the aircraft to hold on to the right float, which they did until the aircraft became too submerged and they all had to swim clear of the aircraft. By the time the boat picked the passengers up the aircraft was fully submerged apart from the two floating skids. None of the passengers was physically harmed.
- 2.8** The remaining four Asian passengers were interviewed on the 25 December 2017 and one of the passengers stated that when he evacuated the cabin he noted that the left float was submerged and the water was up to his hips. All the Asian passengers gave a similar account of the events as did the European passenger however, they did state that after the rescue boat arrived DQ-TAM slowly rolled to the left and became inverted in the water. All the occupants of DQ-TAM were rescued by one red coloured Zodiac craft and two Zodiacs towed DQ-TAM to a point near, but offshore, from the Operator's Base jetty where the tow was abandoned.
- 2.9** An administrative staff member employed by the Operator was also interviewed on the 25 December 2017 and she stated that after assisting the passengers board DQ-TAM she then observed the aircraft taxi normally to the river mouth. Upon reaching the river mouth DQ-TAM then started its takeoff run towards the sea (West) and she observed this while walking from the pontoon to the hangar. After returning to the office another staff member informed her that DQ-TAM was still on the water and then she observed the aircraft a short distance seaward from the pontoon. At this time the aircraft was still upright on its floats.
- 2.10** As the initial phase of the investigation got under way the I in C received information that a person had taken a number of photographs concerning DQ-TAM after it came to a stop on the water. The investigation was able to identify this person, the senior pilot of a local amphibian operation, and on the 28 December 2017 he attended an interview with the investigation. The pilot stated that at approximately 0042 hours UTC (1342 hours local time) on the 24 December 2017 he heard from his house located at Naisoso Island and facing Nadi Bay, an aircraft engine at takeoff power, then a decrease in power followed by a further increase in power for a short period and then the engine noise ceased.
- 2.11** The pilot then went outside of his house and towards the back fence where he observed a DHC-2 aircraft on the water, facing approximately South with the main wings level and the tail touching the water from time to time. The pilot estimated the distance from his position to the aircraft as being approximately 1.5 kilometers.

The pilot then realized that the aircraft was in difficulties and fetched his camera taking a series of photographs as the event unfolded and the investigation was able to view the photographs during the interview.

Realizing their value as evidence which would greatly assist the investigation, the pilot was asked if he could provide the I in C with copies of the photographs but he expressed his reluctance to do this for personal reasons.

The array of photographs started by showing DQ-TAM facing to the South West, motionless in the water with the flaps in the up position and in a tail down attitude, until it eventually rolled over to the left and became inverted in the water. The investigation decided that after a brief break, a further visit to the pilot would be made to try and obtain copies of the photographs by negotiation.

- 2.12** Based on the written statements, interviews with the occupants of DQ-TAM and eye witness accounts, the investigation decided that a detailed inspection of the left float had to be done as a first step to determine the cause(s) of the accident and on the 29 December 2017 a visit was made to the open storage facility at the Lautoka Wharf with the Operator's Chief Engineer.

- 2.13** On arrival DQ-TAM was found to have been placed on a pile of rocks, inverted and both floats placed on top of the fuselage. Accordingly, a close examination of the left float was not possible however, a detailed examination of the left main wing forward attachment bracket was carried out. The fuselage bracket which will be referred to as the "female", was found to be intact and still secured to the fuselage with the wing attachment bolt in place. The nut and split pin which was attached to the bolt were also in place.

The wing bracket which will be referred to as the "male", had separated from the remaining part of the bracket a short distance beyond the hole through which the securing bolt goes through. A small section of the "male" bracket was still secured by the attachment bolt in the "female" bracket. The entire width of the "male" bracket had failed and although the left main wing strut was still secured in place, it is considered likely that the "male" bracket failed due to horizontal impact forces on the wing, not vertical forces. Where the break occurred on the "male" bracket the metal face appeared to the naked eye as being "shiny" which indicated that the break was recent. No part of the break had a dull colour indicating that a crack had started previously. Photographic evidence of the outer section of the forward "lip" of the "female" bracket had moved slightly outwards with the result that the slot between both the forward and aft "lips" of the "female" bracket was slightly wider than the design width. This widening of the outer section of the forward "lip" most likely occurred due to horizontal impact forces on the wing.

- 2.14** The "male" bracket is attached to the main wing spar which also includes a supporting aluminium plate and during the examination it was found that the remaining section of the "male" bracket which backs on to the supporting plate could not be located. Normally, when the wing is attached to the fuselage the securing bolt passes through a hole on one "lip" of the "female" bracket, then the hole in the "male" bracket and supporting plate, and then the hole in the other "lip" of the "female" bracket. A nut then secures the bolt in place and finally a split pin secures the nut. When examined it was found that the hole through the supporting plate had now become the shape of a slot, also indicating horizontal impact forces on the wing.

- 2.15** It very quickly became apparent that the open storage area was not a suitable environment in which to conduct a detailed examination of the components from DQ-TAM and it was decided to transport the aircraft by road to the Operator's Base.
- 2.16** Once DQ-TAM had been deposited at the Operator's Base an examination of both the floats was conducted although emphasis was placed on the left float. Both the floats, according to their data plates, were manufactured by Edo Air but the data plates did not state the year of manufacture nor does the Operator have any information about this. The Operator stated that Edo Air ceased manufacturing floats a number of years ago and the Supplemental Type Certificate (STC) is now held by another company but their name is not known to the Operator. Although aged, both the floats were found to be well maintained and are in good condition. At several places on the hulls and over time, repairs had been carried out to seal punctures which had occurred to the hull skin and this was done by riveting patches on to the affected areas.
- 2.17** A detailed examination of the left float did not reveal any punctures to the skin or indentations which would indicate that the float had struck an object floating in the water on takeoff and where patches had been riveted to the skin, the edges had been made water tight by the application of a sealant. The float exhibited damage at various places which was consistent with the recovery operation of DQ-TAM. Despite the examination no punctures or indentations to the hull skin could be found so it was decided to open the top of the float, place a hose inside to see if any water leaked from the interior of the float.
- 2.18** The top of the float has five aluminium panels which are held in place by numerous screws and by removing these panels, access is gained to the interior sections of the float. In between these panels and approximately midway along the float, is a hatch cover which is hinged at the front and can be moved up or down. By lifting this hatch cover access is then gained to a medium sized compartment inside the float which is used for storing mooring equipment, ropes etc. The hatch cover is held in the closed position by either gravity or by the airflow over it, as the aircraft moves forward in flight. There is no device installed on the float to ensure that the hatch cover is secured in the closed position. Examination of the compartment found that it was clean, well maintained with sealant applied to all the aluminium joints.
- 2.19** Also on the top surface of the float are a number of small circular openings into which, a manual operated pump is placed to draw out any water which may have leaked into the compartments below. In order to ensure that water does not enter these compartments from above during water maneuvering, a small rubber device with a similar shape to a washer, is placed into the circular opening to seal it. The device is secured to the float by string or other similar material. The investigation found that a number of the rubber devices were missing which meant that the associated openings were not sealed.
- 2.20** A hose was placed in the storage compartment and as the water level progressively rose, an examination of the exterior surface of the float did not reveal any leaks.



- 2.21** The investigation then focused on the left wing tip fairing which also serves as a fuel tank, as does the right wing tip fairing. Both tip tanks are only used on long distance flights but as the accident flight was only for a short distance both tip tanks were empty. The left wing tip fairing, which had sustained major damage, is secured by screws to the tip of the left wing and also contains the port (left) navigation light. The damage was consistent with the bottom surface of the fairing striking an object vertically with some force and extending from the leading edge of the fairing to a point approximately half way rearward along the chord. The bottom surface of the fairing was pushed inwards towards the upper surface of the fairing giving it a concave shape and with the upper surface extending above the top surface of the wing. The fairing is secured to the wing tip by a number of screws and it was noted that the fairing screw holes in the vicinity of the leading edge, had become slotted probably due to the vertical and horizontal impact forces. The concave shape of the fairing damage from the leading edge to a point approximately mid chord, suggests that the nose of DQ-TAM was probably yawing to the left when the impact occurred.
- 2.22** The forward right float/fuselage attachment strut bracket had separated at the fuselage and a visual examination of the fuselage and strut bracket faces found that they were both "shiny" and did not reveal any pre-existing crack(s). It is considered likely that the damage occurred during the takeoff run in the existing sea conditions.
- 2.23** The Pilot was further interviewed on the 16 April 2018 and stated that he did not know why the left wing tip fairing was damaged adding that he may have collided with a large bird. With regard to the array of photographs taken by another pilot at Naisoso Island, one showing that the flaps were in the retracted position, he replied that he was sure the flaps were set to the takeoff position prior to takeoff but it was possible that he may have missed the flaps when doing the pre-takeoff checks. Despite viewing a number of pre-selected photographs taken of DQ-TAM when it was on the water, the Pilot was unable to explain the accident sequence and stated that everything contained in his report was what he remembered.
- 2.24** Considering the possibility that the left float of DQ-TAM may have collided with a marker buoy during the early stage of the takeoff, an inspection of the channel marker buoys was conducted on the 18 May 2018 using a zodiac craft supplied by the Nadi Airport RFS. The launching of the zodiac took some time because the custom made cradle in which the craft sits does not have steerable front wheels and RFS personnel find it necessary to drag the front of the cradle by hand to point it in the desired direction when extracting it from the storage facility. Once outside the cradle is then connected to the rear of a vehicle and towed to a random launching point on the nearby beach. Launching the craft from the beach can also be a challenge, especially in moderate to rough seas driven by an onshore Westerly wind as was the case on the day that the accident occurred.
- 2.25** Four plastic marker buoys anchored to the sea bed outline the waterway entrance channel, two markers being anchored on each side of the channel. The first buoy on entering the channel is on the left side and is a small, circular clear plastic beverage container, the second is a maritime red coloured buoy which extends vertically to an estimated height of one meter above sea level. On the right side of the channel and adjacent to the red buoy is a similar shaped green coloured buoy

and further up channel, is a green coloured square, medium sized plastic container commonly used for carrying a variety of liquids. A close examination of these four buoys did not reveal any evidence, paint marks, dents etc, of a collision with the left float.

- 2.26** The Nadi Airport Air Traffic Controller who was on Tower duty when the accident occurred stated in an interview on the 28 May 2018, that at approximately 0030 hours UTC (1330 hours local time) DQ-TAM started its takeoff run near the waterway entrance but not close to the threshold of runway 09. DQ-TAM was heading West. After giving DQ-TAM the takeoff clearance the Controller then had to divert his attention to traffic on the approach for runway 27, Nadi Airport, and did not observe DQ-TAM during the takeoff run. After dealing with the runway 27 traffic he then turned his attention back to DQ-TAM which he could not see as trees in close proximity to the aviation meteorological radar facility, obscured his vision.
- 2.27** He then called DQ-TAM by radio and asked if “ops were normal” and the Pilot, after an estimated 20 – 30 seconds, replied that he needed help. The Controller then stated that he asked an airborne aircraft to fly over DQ-TAM and advise him of the situation. Additionally, he also asked the RFS to launch their zodiac craft to determine the situation of DQ-TAM.  
The airborne aircraft then informed the Controller that DQ-TAM was sinking and he subsequently initiated the rescue procedure.
- 2.28** When comparing what the Controller stated during the interview and his narrative in the Mandatory Occurrence Report (MOR) it became apparent that a difference existed. For example, the MOR states that the Controller “observed DQ-TAM was descending towards the water” however during the interview on the 28 May, he stated that he did not observe DQ-TAM on its takeoff run as his attention was diverted to other landing traffic at the time and also, his vision was obscured by trees. Based on the Pilot and passenger statements that DQ-TAM did not get airborne and the damage suffered during the takeoff run, the investigation considers it unlikely that DQ-TAM became airborne.
- 2.29** The Acting Manager of the Nadi Airport RFS was interviewed on the 1 June 2018 concerning his involvement in the post-accident rescue operation and he stated that he was at his house near the Nadi Airport RFS satellite station (close to the threshold of runway 02) when vehicular traffic passing his home indicated that an aircraft event had occurred. He then received a telephone call from the Operator stating that one of their aircraft had been involved in an accident.
- 2.30** The Acting Manager then proceeded to the RFS storage facility next to the Operator’s Base and on arrival found RFS staff preparing two zodiac craft for launching. One craft was launched from the Operator’s Base sand ramp and the second from the beach South of the Operator’s Base jetty. RFS staff experienced difficulty in starting the engine of the craft being launched from the sand ramp and after discussing this with his staff the Acting Manager stated that it was decided to launch a third and larger zodiac craft using the Operator’s Base tractor.
- 2.31** The Acting Manager then travelled out to DQ-TAM in the bigger craft and on arrival found the smaller craft had already boarded the passengers from DQ-TAM. He then arranged for the craft which he travelled on and two other privately owned boats to tow DQ-TAM, which by now was inverted in the water, as close as

possible to the beach. While DQ-TAM was under tow it continued to sink deeper into the water and accordingly, the tow lines were disconnected after the aircraft had been towed approximately 500 meters. The Acting Manager also stated that when the first craft boarded the passengers, DQ-TAM was still upright on the water but tilting towards the left.

- 2.32** The pilot who took the photographs of DQ-TAM on the 24 December 2017 finally agreed to share them with the I in C and they provide the evidence of what happened to the aircraft after it came to a stop in the water. In all, the pilot took 303 frames using his camera and after viewing them as a "slide show" on a computer, they provided the investigation with the post-accident sequence of events.

The first frame depicts DQ-TAM motionless on the water with the flaps in the retracted position. The aircraft is on an estimated South Westerly heading facing Fantasy Island, numerous white caps resulting from the Westerly wind are visible on the choppy water and the aircraft has a noticeable bank angle with the left wing down. The damaged left wing fairing is visible extending above the top of the left wing.

The tailplane is submerged in the water with only the leading edge of the right horizontal tailplane above the water, an estimated half of the forward left float is visible based on the left wing strut fuselage attachment point, the remainder is submerged in the water. Due to the distance of DQ-TAM from the photographer, an unknown number of persons are visible standing on the forward section of the left float, the propeller is stationary and no boats are visible nearby. Refer Appendix A

- 2.33** Further frames show the left wing slowly but progressively, descending to the water and DQ-TAM turn anticlockwise from the South West towards the East. As it faces to the East, virtually the entire left wing is submerged as is most of the tailplane. The aircraft then continues its turn anticlockwise and faces Naisoso Island by which time only half of the circular (radial) engine is above the water and several persons can be seen on the right float. The anticlockwise turn continues with the aircraft facing West and three persons are seen on the right float. The right wing is nearly at the vertical and most of the fuselage submerged in the water. Refer Appendix B

Still facing West, all that now remains of DQ-TAM above the water is the right float and wing, the engine and a small section of the forward left float, all this indicating that DQ-TAM is sinking on its left side and tail first. A zodiac craft can be seen approaching the aircraft from the shore.

- 2.34** Several frames now show the right wing at an estimated angle of 45 degrees beyond the vertical, the right float above the water and a zodiac craft nearby. DQ-TAM is progressively capsizing to the left. Refer Appendix C

The final series of frames show DQ-TAM facing towards the South West with the side of the right float facing the camera and above the water. The fuselage, wings and the left float are submerged. Later, only the keel surface of the right float is visible.

Evidence from the series of frames confirm that after the takeoff was aborted, water had initially entered the left float and then the fuselage, ultimately capsizing DQ-TAM which then became submerged.

- 2.35** Following a review of the evidence gathered so far the investigation decided to re-visit the left float stored at the Operator's Base. All the compartment panels screwed to the top of the floats were removed and a hose consecutively placed into each compartment, of which there were six. It was noted that the rear compartment of the float has a baffle which divides the compartment into two sections and as the water level rose, it was observed that water seeped past the bottom section of the baffle to the rearmost section of the compartment. As the water level rose in each compartment the exterior surface of the float was checked for leaks but none were observed.
- 2.36** Based on the actions taken so far the investigation was of the opinion that the only way water could have entered the interior of the left float was the possible opening of the unsecured hatch cover by the action of the waves or wind which allowed water to enter the compartment where the mooring equipment was stored and through the openings on the top of the float and into which, the manual pump is placed. As mentioned earlier, some of the openings did not have the rubber seals in place to block the openings. Refer Appendix D
- 2.37** During the preliminary phase of the investigation the loading document for DQ-TAM was obtained and while the passenger names, their associated weights, baggage and cargo weights were recorded on the load sheet, no information had been entered into the columns concerning the total takeoff weight, the position of the center of gravity, maximum and available weights. Several days later the investigation received from the Operator an electronic print-out of the load sheet and center of gravity calculation which depicted the takeoff weight of DQ-TAM immediately prior to the accident as being 2,253 kilograms and the center of gravity position within the envelope at 2.1 inches forward of the aft limit. The takeoff weight was calculated as being 183 kilograms below the maximum takeoff weight of 2,436 kilograms.
- 2.38** In order to confirm the accuracy of the Operator's calculations the investigation did an independent calculation using the Operator's data and the Flight Manual which gave a takeoff weight of 2,261 kilograms, 175 kilograms below the maximum takeoff weight, and the center of gravity position calculated within the envelope at 2.07 inches forward of the aft limit. Although there are minor differences in the takeoff weights and the center of gravity positions concerning both calculations, these differences did not have any impact on the safe operation of DQ-TAM.
- 2.39** Although the Pilot's statement refers to the takeoff run of DQ-TAM starting within the waterway entrance, which is orientated on a East/West heading, the investigation found that in fact the takeoff run commenced seaward of the waterway entrance and continued on a South Westerly heading. This is based on independent photographic evidence taken by another pilot when the takeoff was aborted and DQ-TAM was stationary on the water facing approximately South West. The pilot photographed DQ-TAM from a point on Naisoso Island and in the distance beyond DQ-TAM is a small sandy beach which is located on the Western end of Fantasy Island and by connecting these two points with a line, the direction from Naisoso Island to the beach would be approximately towards the South West. When interviewed, the Controller stated that he thought DQ-TAM commenced the takeoff run towards the West from the waterway entrance but as the interview progressed the Controller then stated that he could not see DQ-TAM due to the



trees near the weather radar facility, both of which are located approximately to the South West of the Control Tower. Had DQ-TAM started its takeoff run towards the West, as initially stated by the Controller, it would have been visible to him throughout the entire departure phase and finally, the GPS co-ordinates of DQ-TAM as recorded by the CAAF Inspectors when they arrived at the accident site, place the aircraft in an area nearly abeam the Operator's Base.

- 2.40** The Nadi Airport METAR at 0000 hours UTC on the 24 December 2017 (1300 hours on the 24 December 2017 local time, 44 minutes before the accident occurred), the closest weather observation from the accident site, states that the wind was 280 degrees true (from the West) at 13 knots and with the takeoff run of DQ-TAM on an approximate South West track (227 degrees true), this would have presented the Pilot with a calculated crosswind component of 10 knots and wind generated wave/swell lines, orientated North/South, but moving from the West to the East. The head wind component for the takeoff was calculated as 7 knots.
- 2.41** The Normal Procedures, Section 2, page 26 of the Aircraft Flight Manual contains a statement in paragraph 2.14.2 which specifies the crosswind takeoff and landing limitations for the DHC-2 seaplane (floatplane). The limitation states that the lateral component of wind velocity at and below which it is safe to takeoff and land is not more than 10 miles per hour (mph) at 90 degrees for seaplanes. Ten mph is equal to 8.7 knots and with DQ-TAM being subjected to a calculated crosswind component of 10 knots on the takeoff run, the Aircraft Flight Manual limitation of 8.7 knots was exceeded by 1.3 knots, a minimal amount but nonetheless, the limitation was exceeded.
- 2.42** Canada is a land of many inland waterways and lakes so small aircraft equipped with floats are very popular as a means of providing quick and easy access to places where the population can participate in leisure activities such as fishing, hunting etc. Typically the inland waterways and lakes will be sheltered from the wind by the surrounding topography with the result that the waves will be small and there will be virtually no swell and with this in mind, float manufacturers have designed and built floats which are capable of handling these wave conditions. Fiji however has a completely different environment in which floatplanes operate, the open and unprotected sea, even within a lagoon, is susceptible to strong winds with the correspondingly large waves and accompanying swell resulting in these conditions presenting operational challenges to pilots.
- 2.43** The DHC-2 Aircraft Flight Manual contains numerous references about operations involving the use of floats but no limitations could be found on the maximum wave and swell heights in which floats may be used. Discussions with the Regulator on this limitation revealed that questions had been sent to a USA float manufacturer in the past but no response had been received. When asked, experienced floatplane pilots replied that assessing when the sea conditions are suitable for takeoff and landing depends on personal experience.
- 2.44** The Pilot stated in an interview that he was apprehensive about taking off in the sea conditions which existed at the time and this probably influenced his decision to takeoff towards the South West and accept the crosswind rather than takeoff into the wind, the normal procedure, and subject DQ-TAM to the continual buffeting from the waves and swell during the takeoff run.

As the Pilot commenced his takeoff run towards the South West DQ-TAM was calculated by the Operator to be 183 kilograms below the maximum takeoff weight which would indicate to the Pilot that the takeoff run would be longer than if the takeoff weight was lower and with a head wind component of 7 knots, only a minimal advantage in takeoff performance could be obtained. Due to the wave height and lines moving from West to East, DQ-TAM would have been rolling back and forth, this being exacerbated by the westerly wind strength of 13 knots, the inertia of the aircraft with its near-capacity cabin payload of passengers and baggage resulting in the aircraft being "top heavy", that is, the aircraft center of gravity being some distance above the surface of the water, a feature of floatplanes where the aircraft fuselage is attached above the floats.

- 2.45 As DQ-TAM gathered speed during its takeoff run the rolling motion probably increased progressively in frequency and with the Westerly wind striking the right side of the fuselage, the Pilot would have found maintaining directional control with the rudder and lateral control with the ailerons, extremely challenging.
- 2.46 At some point during the takeoff run the right main wing probably rose a significant height above the sea due to the rolling motion and exposed the lower section of the wing to the Westerly wind which may have forced the wing even higher. It may have been at this time that the left wing tip struck the top of a wave with some force and the combined effect of these actions, in addition to most of the aircraft weight acting on the left float, may have caused the forward section of the left float to become partially submerged in a wave resulting in DQ-TAM yawing to the left as mentioned by the Pilot in his statement, refer paragraph 1.18.4.
- 2.47 If the forward section of the left float became partially submerged water could have entered the interior of the left float through the possible opening of the unsecured hatch cover by the action of the waves or wind which allowed water to enter the compartment where the mooring equipment was stored and through the openings on the top of the float and into which, the manual pump is placed. As mentioned earlier, some of the openings did not have the rubber seals in place to block the openings.
- 2.48 Nonetheless, the photographs of DQ-TAM taken by the pilot on Naisoso Island after the aircraft came to a stop show that water continued entering the left float until DQ-TAM ultimately capsized to the left and became submerged.
- 2.49 The single forward left hand main wing attachment bracket (secures the wing to the fuselage) had failed and found to be in two pieces although the wing securing bolt remained intact and secured in one piece of the bracket, refer Appendix E. It is considered likely that this failure occurred during the takeoff run when the left wing tip struck the water, probably a wave top, with some force and combined with the forward speed of DQ-TAM, vertical and horizontal impact forces acting on the wing tip may have resulted in the bracket failure.
- 2.50 Section 2.32 states that *"the first frame depicts DQ-TAM motionless on the water with the flaps in the retracted position"* and when interviewed about the flap position the Pilot stated that he was sure the flaps were set to the takeoff position before takeoff but that it was possible he may have missed setting the flaps before takeoff.

It is considered unlikely that he forgot to set the flaps to the takeoff position based on his considerable overall experience as a floatplane pilot and further, that the flap position indicator for the DHC-2 is located on the instrument panel directly in front of the pilot. The most likely explanation for the flaps being in the retracted position when DQ-TAM was motionless on the water maybe due to the Pilot selecting the flaps to that position thus permitting the passengers in row 2 and 3 to rapidly exit the cabin through the left rear door without suffering from any head injuries due to possibly impacting with the extended flaps.

- 2.51** The flaps are operated by an actuating cylinder located in the fuselage near the left wing root. Hydraulic fluid is supplied to the actuating cylinder by a hand pump, under the pilot's seat. This hand pump has an integral reservoir, a selector valve, and a relief valve. The relief valve is set at 1,000 psi.  
After DQ-TAM was transported to the Operator's Base examination of the actuating cylinder found that the actuating rod was fully retracted within the cylinder which confirmed that the flaps were in the up, or retracted position.
- 2.52** The forward right float/fuselage attachment strut bracket had separated at the fuselage and this most likely occurred during the takeoff run when the wave lines were moving in an Easterly direction and striking the right side of the float. The rolling motion of DQ-TAM would also have increased the impact forces acting on the right side of the float.
- 2.53** Page 7 of the Operator's Route Guide contains information of importance to pilots about operating in the vicinity of the Operator's Base. The pictorial display includes the threshold area of runway 09 at Nadi Airport, the reef located within Nadi Bay and the directions in which takeoffs and landings maybe done. Takeoffs and landings maybe done towards the West from a point seaward of the coastline and aligned along the extended centerline of runway 09/27. Takeoffs and landings may also be done from a point seaward of the coastline and approximately midway from the threshold of runway 09, Nadi Airport, and the Operator's Base. The direction faces to the West.  
The third direction at which takeoffs and landings maybe done is towards the Northeast/Southwest and this direction approximately parallels the coastline of Nadi Bay spanning a distance from the mid-point between the threshold of runway 09 and the Operator's Base to an area seaward of Wailoloa settlement.  
The bottom section of the page discusses the normal takeoff/landing area, strong winds and heavy swell takeoff/landing area, low tide, loading/unloading of passengers, approach/takeoff over populated areas and engine failure directions. Refer Appendix F
- 2.54** Of particular interest to this investigation are the comments made in the Route Guide concerning the strong winds and heavy swell takeoff/landing area which are as follows, "*Over the sand bank, or Northern corner of the beach, or the Southern side of the jetty or in the boat channel on the South side of Naisoso Island (axis of runway 09/27) or paralleling the beach. Limit the payload*". This was the area which the Pilot of DQ-TAM attempted to takeoff and while a condition of the Route Guide states to "limit the payload", the condition does not give any guidance or direction to pilots as to the limit of the payload. Further, there is no reference at the bottom section of the page reminding pilots of the manufacturer's crosswind limitation for the DHC-2 floatplane, no guidance information to pilots as to the

maximum wave/swell heights in which floatplane operations may be conducted and the company policy on pilots conducting floatplane operations in waters that have numerous “white caps” generated by strong winds

- 2.55** In accordance with Air Navigation Regulation (ANR) 49 as applicable to public transport operations, Operators are required to implement a scheme approved by the Regulator, for the regulation of flight times, duty and rest periods and although in practice the Operator’s individual pilots maintain a daily record, final responsibility for compliance with the regulation rests with the Operator. A review of his Flight and Duty Time records found that the Pilot entered his data into a specific computer programme, supplied for this purpose by the Operator and accepted by the Regulator, which will automatically alert the pilot if any of the Regulatory limitations associated with the scheme are about to be exceeded. Another key benefit of this computer programme is that it provides a daily “running total” of the previous hours worked in relation to flight and duty times when compared to the daily, weekly, monthly (28 days) and annual Regulatory limitations.
- 2.56** The review also found that although the Pilot commenced employment with the Operator on the 2 April 2017, the year reflected in the records for the duration of his employment was 2015 and why this anomaly in the computer programme was not corrected by the Operator in a timely manner could not be determined. Further, in order to confirm the accuracy of the records they were compared using the audit methodology with the entries recorded in the Aircraft Technical Logs by the Pilot and the records were determined to be accurate. The records show that from the commencement of his employment and up to the 3<sup>rd</sup> week of December 2017, the Pilot did not exceed any of the limitations associated with the scheme and had regular days off, that is, free from duty obligations. From the beginning of December until the 20 December 2017 the “running total” progressively increased from approximately 75 flying hours until the 21 December when the 100 flying hour limitation was exceeded but over this period, neither the Pilot or the Operator appear to have taken note of this progressive increase and initiated any corrective actions in a timely manner. The records show that for the 21 December 2017 the Pilot had completed 100.10 hours flying and exceeded the 28 day “running total” Regulatory limitation of 100 hours by 0.10 of an hour, on the 22 December 2017 the Pilot had completed 100.50 hours flying and exceeded the limitation of 100 hours by 0.50 of an hour and on the 24 December 2017, the day of the accident, the Pilot had completed 100.90 hours of flying and exceeded the limitation of 100 hours by 0.90 of an hour.
- 2.57** On the 22 December 2017 the records show that the Pilot had completed 4.80 hours flying and 8 hours duty, on the 23 December he had a day free of duty and on the 24 December, he completed 4 hours flying with 7.50 hours duty.
- 2.58** When asked why the Pilot’s flying hours were not reduced on the 21 December 2017 thus preventing the 28 day flying hour limitation being exceeded, the Operator did not supply the investigation with a response that would be considered appropriate. The same applied to questions concerning the limitations being exceeded on the 22 and 24 of December 2017. The investigation could not determine whether the Pilot had informed the Operator beforehand that his 100 flying hour limitation would be exceeded on the 21 December 2017, which he had



a duty to do, or of the subsequent limitations being exceeded on the 22 and 24 December 2017. By exceeding the 100 hour flying limitation on the 21, 22 and 24 December 2017 during midsummer when ambient ground temperatures can reach 32 degrees centigrade, it is possible that the Pilot may have suffered from a measure of fatigue when the accident occurred.

- 2.59** The company Operations Manual contains a section titled Personnel Responsibilities, section 2.2, page 2-2, applicable for each senior post holder and one of the key responsibilities of the Chief Pilot, sub section 3 of the same page, is to ensure the following, *“c) provide a duty roster to each pilot, ensuring it is in conformance with the Air Navigation Regulations”* and although the Pilot was holding an Acting Chief Pilot post, he was still required to comply with the Chief Pilot responsibilities as specified in the Operations Manual.
- 2.60** The Operations Manual, chapter 5, contains the Operator’s Pilot Flight and Duty Times (also known as the scheme) which specifies how the Operator will comply with the ANR’s and manage the risks associated with pilot fatigue.
- 2.61** During May 2018 the Regulator conducted the annual Air Operator Certificate of Competency (AOC) renewal audit which essentially reviews the Operators manuals and documentation spanning over the previous 12 months from the date of the audit and this also included the date when the accident occurred. The work pack containing the Regulator’s checklists and other documentation associated with the May 2018 audit included a Flight Operations AOC Renewal Audit Checklist, number OP123B, which consists of 9 pages and lists all the key items that should be scrutinized during the audit however, the checklist does not state the date when the audit comments were entered by the Regulator. A review of the checklist found that the Regulator had entered a number of comments on the various sections and pages of the checklist however, section 2.C7, page number 6 of 9, which is applicable to the Operator’s Flight Times Limitations did not contain any entries or comments from the Regulator when the audit was conducted and accordingly, it is concluded that the Operator’s Flight and Duty records may not have been subjected to any scrutiny by the Regulator during the audit.
- 2.62** According to the AOC Flight Operations renewal audit report the Regulator identified 5 Level 2 Findings during the audit but none of these Findings were related to the Operator’s Flight and Duty records or the scheme.
- 2.63** Section 2.6 of this report states that *“all the aircraft occupants were in the water wearing their inflated lifejackets for approximately 10 – 15 minutes before the boat arrived to pick them up”*, Section 2.8 states that *“all the occupants of DQ-TAM were rescued by one red coloured Zodiac craft”* and Section 2.31 states *“and on arrival (the Acting Manager Nadi Airport RFS) found the smaller (RFS) craft had already boarded the passengers from DQ-TAM”*. The significance of these 3 statements is that the Operator was not able to assist in the prompt recovery of the Pilot and passengers from the water and when asked why assistance could not be offered, the Operator stated that at the time of the accident occurring a medium sized dinghy manufactured from composite materials which the Operator owned was undergoing repairs at the Operator’s Base, the



outboard engine was undergoing overhaul at their offshore resort and therefore, they were not able to provide any assistance.

**2.64** The Operations Specifications which was valid at the time of the accident occurring and is a component of their Regulator issued AOC, states the following on page 5 of the Specifications, *"the operator shall, in accordance with guidelines published by the Authority, implement a Safety Management System acceptable to the Authority"* and in order to assist operators with this requirement, the Regulator provides Industry with a Standards Document, Safety Management Systems on its website.

**2.65** The temporary absence of any readily available maritime rescue craft owned by the Operator and which could be used for events such as this, prompted the investigation to review the Operator's Safety Management System (SMS) and associated documentation to determine if it was an active and fully functioning system. The review identified the following deficiencies;

- The Organizational Structure included the names of personnel no longer employed by the Operator.
- The Organizational Chart is depicted as a vertical line with only 1 person reporting directly to the Accountable Manager.
- The Emergency Response Plan, a component of the SMS, does not include a scenario should a company aircraft suffer from a mishap on the water with the possibility of becoming submerged in the vicinity of the Operator's Base.
- There is no documentation available to staff on the use and management of the Base maritime rescue craft.
- There is no documentation available to staff on the accessibility of maritime rescue craft at off-shore resorts and regularly serviced by the Operator's aircraft.
- The Regulator's copy of the Operator's SMS Manual has not been amended since 2013.
- There are no records available of any Hazard Identification reports and how the risks were mitigated.
- There are no records available of any previous periodical SMS meetings with the Accountable Manager and staff.
- There has not been an SMS based internal investigation by the Operator into the sinking of DQ-TAM.

**2.66** Examination of the Regulator's electronic Aviation Quality Database (AQD) found that the last dedicated SMS audit conducted by the Regulator with the Operator was dated 9 August 2016 and 5 Findings were identified. One Finding was related to the Emergency Response Plan and that it needs to be reviewed and

communicated to all staff, the second that safety meeting Minutes were required to be more formal and filed. The other 3 Findings were of a generalized nature.

### **3 FINDINGS**

3.1 Findings identified during the investigation are listed below.

3.1.1 The Pilot was appropriately licenced, rated and medically fit for the flight.

3.1.2 There is no evidence on his company licencing file confirming that the Pilot, since commencing employment with the Operator, had satisfactorily completed a Dangerous Goods Awareness course acceptable to the Regulator. Dangerous Goods Awareness requirements for pilots are discussed in the CAAF Aeronautical Information Circular (AIC), number 08/05.

3.1.3 There is no evidence on his company licencing file confirming that the Pilot, since commencing employment with the Operator, had satisfactorily completed a Crew Resource Management (CRM) course acceptable to the Regulator. CRM requirements for pilots are discussed in the CAAF AIC, number 03/13.

3.1.4 Evidence on his company licencing file states that the pilot had completed the thirteenth month ANR 45 Dry Drills Emergency Procedures training on the 22 September 2016 and completed the written examination on the 6 April 2017 however, the Operator did not provide the Pilot with a certificate stating that he had satisfactorily completed the Emergency Procedures training, the mark which he obtained at the completion of the examination and the name of the CAAF approved Emergency Procedures Instructor.

3.1.5 DQ-TAM held a Certificate of Airworthiness valid until the 16 August 2018.

3.1.6 The Certificate of Release To Service (CRS), number 0072 and applicable for DQ-TAM (Category A aircraft, Category C engines) was valid at the time the accident occurred.

3.1.7 The Technical Log pages applicable to the 23 - 24 December 2017 and the Technical Log pad were not available due to DQ-TAM becoming submerged in Nadi Bay for a number of days with the documentation remaining on board. Technical Log records are only available up to and including, the 22 December 2017.

3.1.8 The passenger names, their associated weights, baggage and cargo weights were recorded on the load sheet however, no information had been entered into the columns concerning the total takeoff weight, the position of the center of gravity, maximum and available weights.

3.1.9 The Operator's Route Guide states the following limitation when conducting a takeoff at Nadi Bay in heavy swells and strong winds, "***paralleling the beach. Limit the payload***". However, the condition does not give any guidance or direction to pilots as to the limit of the payload. Further, there is no reference at the bottom section of the page reminding pilots of the manufacturer's crosswind limitation for the DHC-2 floatplane.

- 3.1.10 There is no information in the Operator's Route Guide informing pilots as to the maximum wave/swell heights in which floatplane operations may be conducted and the company policy on pilots conducting floatplane operations in waters that have numerous "white caps" generated by strong winds.
- 3.1.11 The flight and duty time records show that for the 21 December 2017 the Pilot had completed 100.10 hours flying and exceeded the 28 day "running total" Regulatory limitation of 100 hours by 0.10 of an hour, on the 22 December 2017 the Pilot had completed 100.50 hours flying and exceeded the limitation of 100 hours by 0.50 of an hour and on the 24 December 2017, the day of the accident, the Pilot had completed 100.90 hours of flying and exceeded the limitation of 100 hours by 0.90 of an hour.
- 3.1.12 A review conducted by the Investigation found that at the time of the accident occurring, parts of the Operator's Safety Management System were not functioning in accordance with the Regulatory requirements.
- 3.1.13 Although not confirmed, the accident was most likely caused by the left float becoming partially submerged due to the Westerly wind and the moderately rough sea during the takeoff run towards the South West. When partially submerged, water probably entered the left float through an unsecured hatch cover and openings along the top surface of the float and this probably continued after the Pilot aborted the takeoff. Eventually and confirmed by photographic evidence, DQ-TAM rolled over to the left, probably due to the weight of water in the left float and finally, came to rest on the sea bed, inverted.

#### **4 CONTRIBUTORY CAUSES**

- 4.1 The following contributory causes were considered during the accident investigation.
- 4.1.1 The sea state was moderately rough and the Pilot stated during an interview that he was apprehensive about taking off in these conditions.
- 4.1.2 As the Pilot commenced his takeoff run towards the South West DQ-TAM was calculated by the Operator to be 183 kilograms below the maximum takeoff weight and with its near-capacity cabin payload of passengers and baggage resulted in the aircraft being "top heavy", that is, the aircraft center of gravity being some distance above the surface of the water, a feature of floatplanes where the aircraft fuselage is attached above the floats.
- 4.1.3 Due to the wave height and lines moving from West to East, DQ-TAM would have been rolling back and forth, this being exacerbated by the westerly wind strength of 13 knots and the inertia of the aircraft.
- 4.1.4 The Aircraft Flight Manual specifies the crosswind takeoff and landing limitation is not more than 10 miles per hour (mph) at 90 degrees for DHC-2 seaplanes. Ten mph is equal to 8.7 knots and with DQ-TAM being subjected to a calculated crosswind component of 10 knots on the takeoff run, the Aircraft Flight Manual limitation of 8.7 knots was exceeded by 1.3 knots.

- 4.1.5 By exceeding the 100 hour flying limitation on the 21, 22 and 24 December 2017 in midsummer when ambient ground temperatures can reach 32 degrees centigrade during early afternoon, it is possible that the Pilot may have suffered from a measure of fatigue when the accident occurred.

## **5 SAFETY RECOMMENDATIONS FROM THE PRELIMINARY REPORT**

- 5.1 As the accident investigation progressed the Investigator in Charge sent the following initial safety recommendations contained in the Preliminary Report to the Department of Civil Aviation, dated the 7 May 2018;
- 5.1.1 All Operators ensure that motorized boats are readily available for all aircraft takeoff and landing maneuvers on the water in order to provide a rapid rescue response in the event of an aircraft mishap occurring. Motorized boats could be provided by the Operators or the resorts which they service.
- 5.1.2 All Operators review their Emergency Response Plans to ensure that procedures are in place for a rapid rescue response in the event of an aircraft mishap occurring on the water.
- 5.1.3 All Operators specify in their Operations Manuals or Route Guides the maximum wave height on which water maneuvers by float and amphibious aircraft maybe conducted.
- 5.1.4 All Operators specify in their Route Guide alternative water maneuvering areas which may be used in the event that the open water is too rough. The Route Guide must also state the safety procedures to be implemented by Pilots before using these alternative areas, for example, ensuring that partially submerged logs or other semi-floating objects do not pose a safety threat to aircraft operations.
- 5.1.5 The Operator ensure that a sufficient number of pilots are employed in order to continuously comply with their regulatory approved Flight and Duty Time Scheme.
- 5.1.6 The Operator ensure that at the end of each day's flying activities the relevant and completed Technical Log page is removed from the Log by the Engineering Department and placed in the appropriate file for future reference.
- 5.1.7 The Operator ensure that all company pilots correctly complete the aircraft Load Sheet in accordance with the regulatory requirements by entering details applicable to the total weight, center of gravity calculation, maximum and available weight, passenger surnames and the Pilot's signature with date.

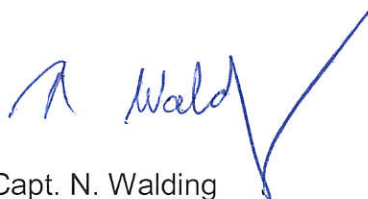
## **6 SAFETY RECOMMENDATIONS FOR THE REGULATOR**

- 6.1 As the accident investigation progressed the Investigator in Charge sent the following initial safety recommendations to the Regulator, dated the 28 May and 1 June 2018;

- 6.1.1 That an investigation be carried out by the Regulator to determine if the trees located in close proximity to the meteorological radar facility obscure the vision of Nadi Airport Control Tower staff and if so, implement the necessary corrective actions to ensure that the water maneuvering area for floatplane operations within Nadi Bay is visible from the Control Tower.
- 6.1.2 That the Regulator ascertain if the front wheel axles of all the mobile zodiac rescue craft cradles used by the Nadi Airport Rescue Fire Service be modified so the front wheels can be steered when they are towed by a vehicle.
- 6.1.3 That the Regulator ascertain if a more suitable launch site for the zodiac rescue craft into Nadi Bay can be found along the ramp (from the RFS satellite Base) to the pontoon.

## **7      RESPONSES TO THE DRAFT REPORT**

- 7.1      Following completion of the draft accident report the Investigator in Charge recommended to the Department of Civil Aviation in a letter, dated the 1 April 2019, that an invitation be extended to interested parties whereby they could make comments on the content of the draft report. The letter also stated that the Investigator in Charge should receive any comments no later than the 27 May 2019.
- 7.2      As the Investigator in Charge has not receive any responses from interested parties by the 18 July 2019, the investigation has been concluded by publication of the Final Report.

A handwritten signature in blue ink, appearing to read 'N. Walding', with a long, sweeping checkmark-like stroke extending from the end of the signature.

Capt. N. Walding  
**Investigator in Charge**

18<sup>th</sup> July 2019





## Appendix A





## Appendix B





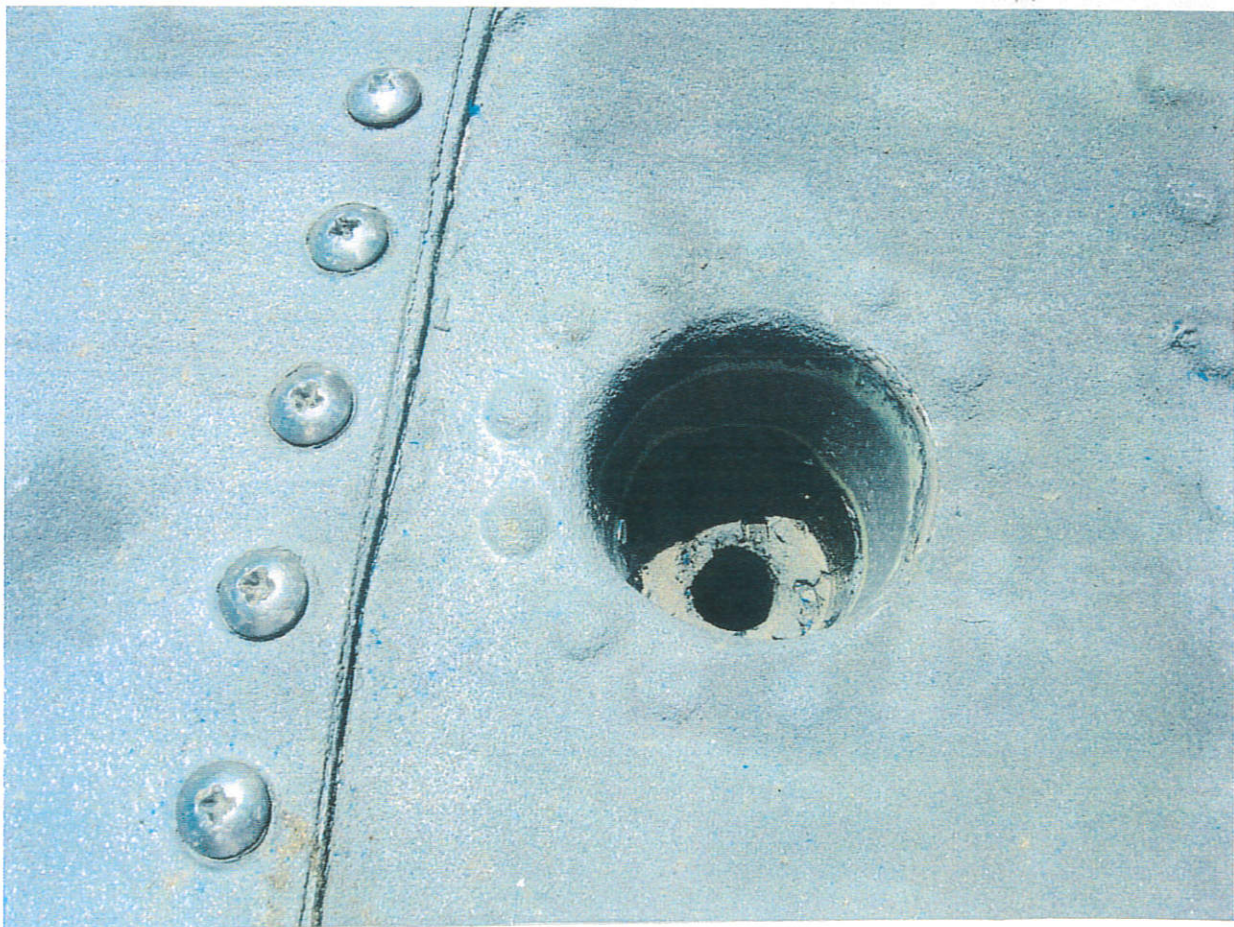
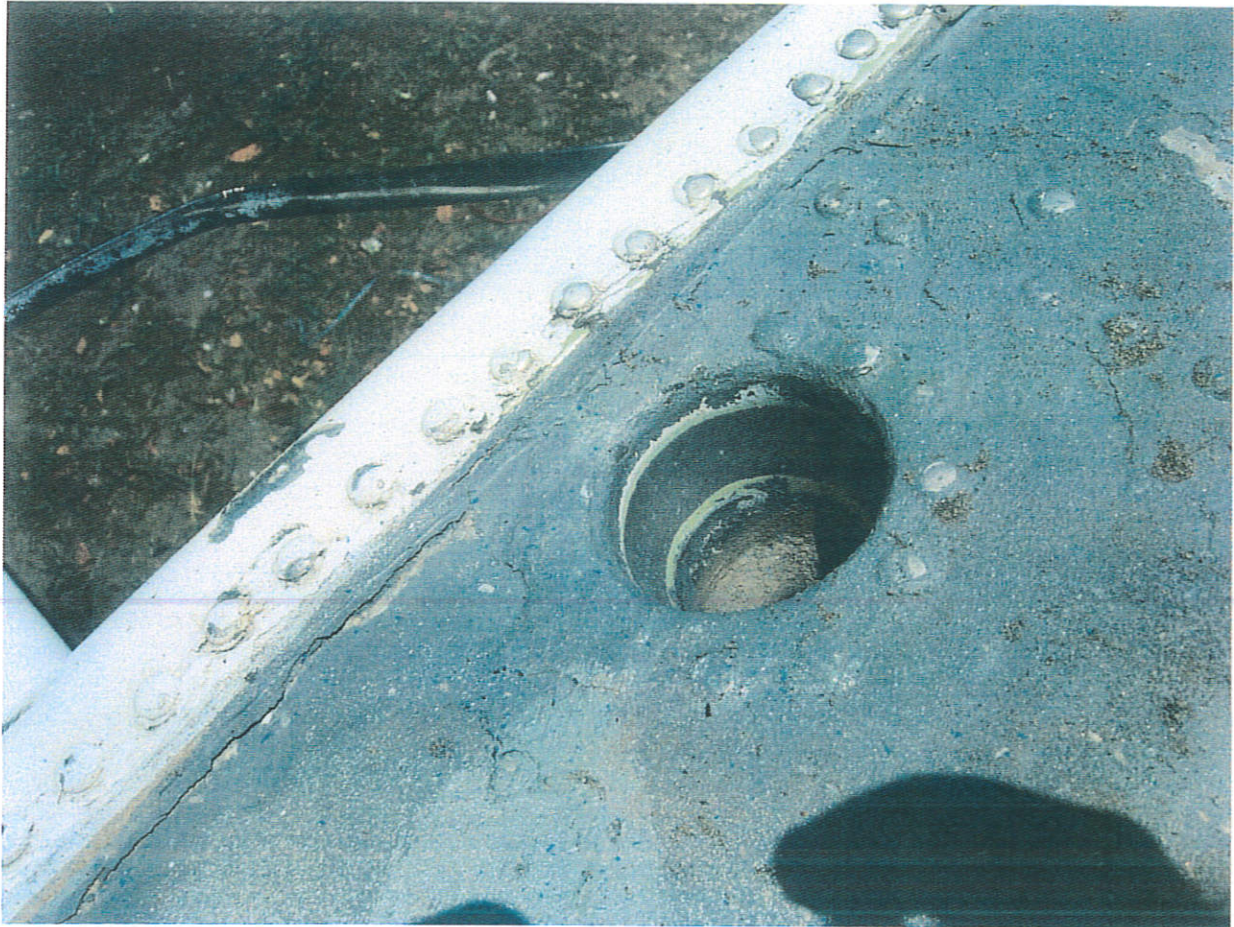


## Appendix C





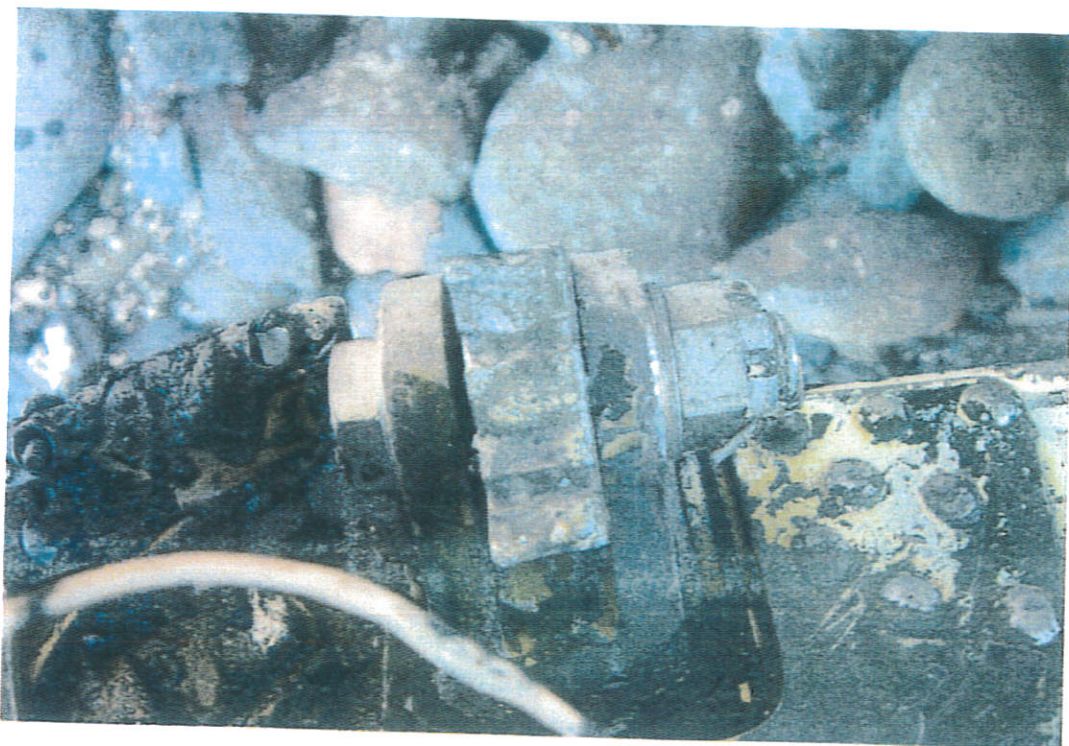
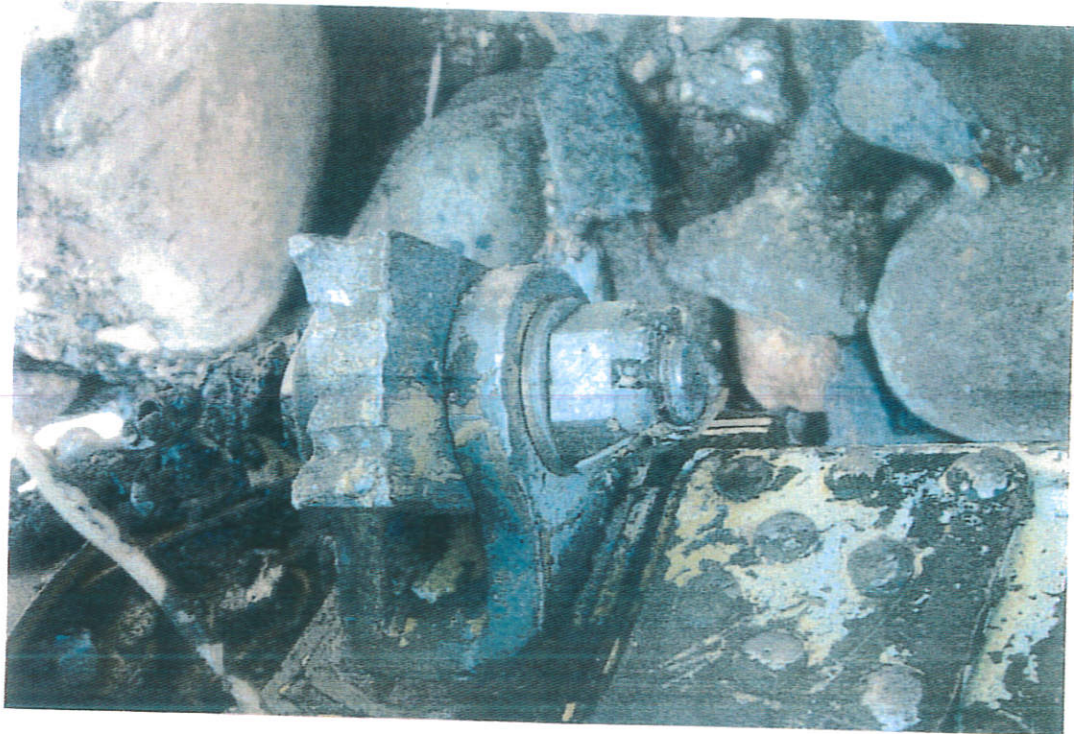




## Appendix D





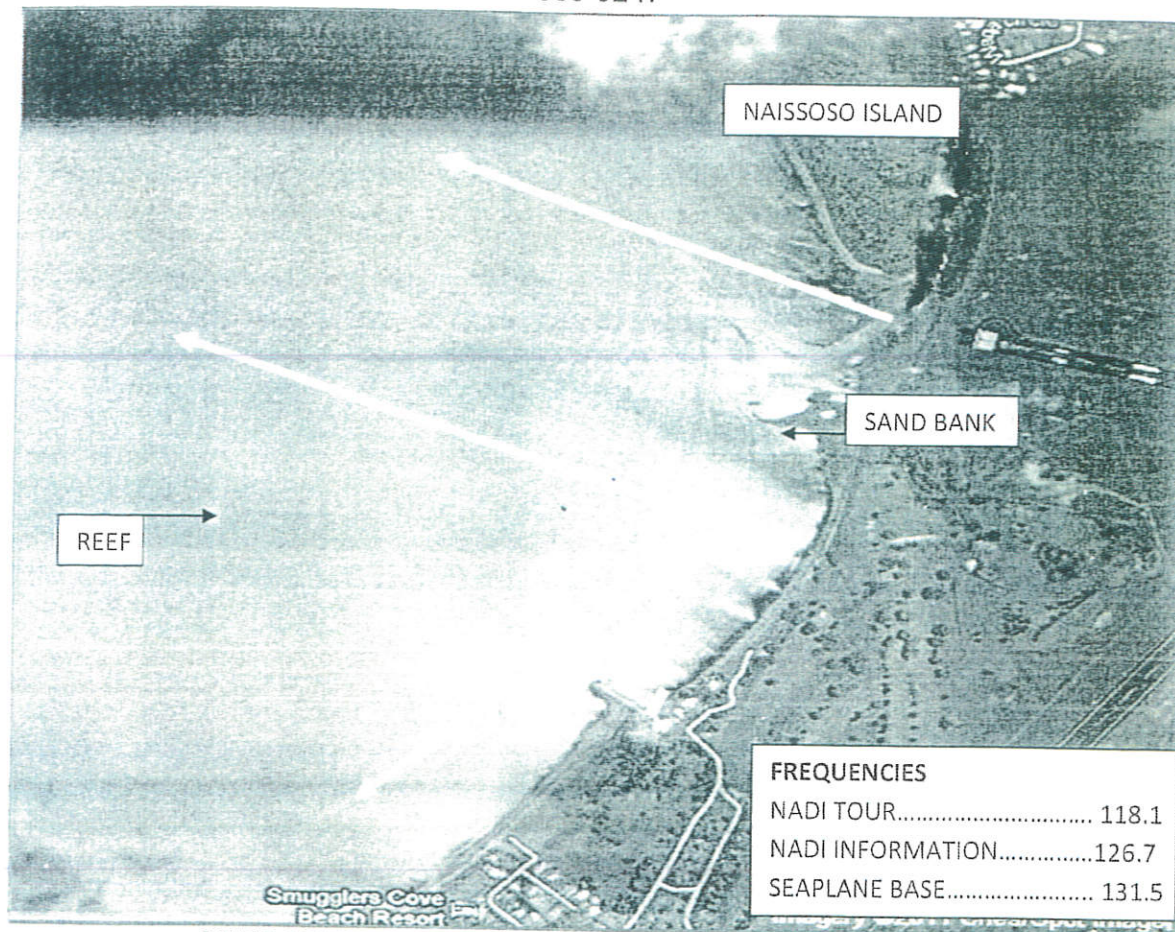


## Appendix E





NADI SEAPLANE BASE – S 17.45.35 / E 177.25.4  
866-9247



### OPERATING REQUIREMENTS AND CONSIDERATIONS

**Normal takeoff / landing area:** Northern side of jetty. On a East West heading north side of the jetty, or paralleling the beach on a Northeast or Southwest heading.

**Strong winds / heavy swell, takeoff / landing area:** Over the sand bank, or northern corner of the beach, or the Southern side of the jetty or in the boat chanel on the south side of Naissoso Island (axis of Runway 09/27) or paralleling the beach. Limit the payload.

**At low tide:** watch for rocks around the dock and the reef 300 meters west of the jetty (marked with reef marker).

**Load and unload the passengers:** at the dock.

**Avoid overland approach and take off over populated areas.**

**Engine failure:** Aim for the protected side of the islands or reefs. Do not land on the reef or sand bank at low tide.

## Appendix F

