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ACCIDENT INVESTIGATION COORDINATING COMMITTEE  
CIVIL AVIATION DEPARTMENT  
MINISTRY OF TRANSPORT AND CIVIL AVIATION

**ACCIDENT REPORT ON  
8Q-TMC (TWIN OTTER) COLLISION WITH SEAWALL  
At Male' International Airport  
On 17<sup>th</sup> of May 2004**

**Operator: Trans Maldivian Airways Pvt. Ltd.  
Manufacturer: De Havilland  
Model: DHC-6-300 (Floatplane)**

## INTRODUCTION

Maldives is a signatory to Convention on International Civil Aviation (Chicago 1944) which established the International Civil Aviation Organisation. Article 26 of the Chicago Convention obligates the conduct of accident investigation of civil aircraft occurring in their state.

The Accident Investigation Coordinating Committee (AICC) under the authority of the Director General of Civil Aviation conducted the investigation.

The AICC was assisted by accredited representatives from Transport Safety Board and Pratt and Whitney of Canada and Flight Operations staff and Airworthiness staff of Civil Aviation Department (CAD).

The Accident was notified to CAD at 1106 hrs (LT) by Area Control Centre. ICAO, and Transport Canada was notified soon after by CAD.

In accordance with Annex 13 to Convention on International Civil Aviation, it is not the purpose of this investigation to apportion blame or liability. The sole objective of this investigation and the Final Report is to prevent accidents and incidents.

Unless otherwise stated recommendations in this report are addressed to the CAD. It is CAD who will decide on implementation.

All times in this report are in Local Time unless otherwise stated. Time Difference between Local and UTC is +5 hrs.

The report is released by the Chairman of the Accident Coordinating Committee on August 15, 2004

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## **List of Abbreviations**

<b>TMA</b>	: Trans Maldivian Airways Pvt. Ltd
<b>LT</b>	: Local time
<b>CAD</b>	: Civil Aviation Department
<b>PIC</b>	: Pilot in command
<b>SIC</b>	: Second in command
<b>LHS</b>	: Left hand side
<b>RHS</b>	: Right hand side
<b>C of A</b>	: Certificate of Airworthiness
<b>C of R</b>	: Certificate of renewal
<b>NSS</b>	: National Security Service
<b>MTOW</b>	: Maximum takeoff weight
<b>T/O</b>	: Take off
<b>MAR</b>	: Maldivian Airworthiness Requirements
<b>CB</b>	: Circuit breakers
<b>EW</b>	: East west
<b>SOP</b>	: Standard Operating Procedures
<b>PT</b>	: Power turbine
<b>P3</b>	: Compressor Discharge Air Pressure
<b>Py</b>	: Governor Servo Pressure
<b>CT</b>	: Compressor Turbine
<b>VFR</b>	: Visual Flight Rules

## Synopsis

The aircraft commenced its flight with 14 passengers from Male' International Airport to Velaavaru Resort Island in Dhaalu Atoll. ATC clearance for west bound departure was obtained before the aircraft taxied from TMA dock for take-off from the water runway 30, with an available take-off and manoeuvring distance of approximately 1000metres up to the seawall. The take-off proceeded normally though it did take longer than normal to lift-off.

The aircraft appeared to be accelerating slowly (as per the passengers); pilots understood it to be a normal flight; approaching the sea wall captain realising the height of the aircraft, pulled on the controls to clear the obstacle; leading to a stall. The aircraft's left hand side (LHS) float struck the sea wall shearing it off. When the left float got detached; the left engine still running at power; folded the wing upwards from attachment point to fuselage. As the wing came down it got detached from the wing forward attachment point to fuselage and left propeller cut through the cockpit ceiling. As the aircraft ran into the ground, the right hand side (RHS) float flew off and hit the propeller and the propeller came loose. The aircraft continued skidding on the fuselage along the grass and came to a stop on the main land runway.

Both the flight crew and one passenger suffered serious injuries. Only one passenger had a minor injury whilst others walked uninjured.

The accident occurred due to collision of the left hand side (LHS) float with the sea wall.

*The investigation identified the following causal factors:*

The crew failed to select the flaps to the standard 20 degrees as required.

The crew failed to abort the take-off.

The Pilot-in- Command did not take any action to abort the take-off as the aircraft approached the sea wall.



## 1. FACTUAL INFORMATION

<b>Operator:</b>	Trans Maldivian Airways Pvt. Ltd. (Maldivian Air Operator Certificate Holder No.001)
<b>Aircraft Type:</b>	DHC-6-300 (on Wipline floats)
<b>Aircraft Manufacturer:</b>	De Havilland
<b>Aircraft Owner:</b>	Ashe Aircraft Enterprises Pvt. Ltd. (Canadian Company) leased to Trans Maldivian Airways
<b>Nationality:</b>	Maldivian registered
<b>Registration:</b>	8Q-TMC
<b>Place of Accident:</b>	Male' International Airport (Latitude: 04° 11' North Longitude: 007° 33' East)
<b>Date and Time:</b>	17 <sup>th</sup> May 2004 at 1101 hrs

### 1.1 History of Flight.

17<sup>th</sup> May 2004 was a Monday; the busiest day of the week when there is an average of 150-200 movements. 8Q-TMC completed two flights (04 legs) prior to the accident, with the same flight crew.

Fourteen pieces of baggage were to be loaded initially, in the aft cabin, with total weight of 620 lbs. Five pieces of baggage totalling to 247 lbs were off-loaded later, making the total weight of remaining nine pieces of baggage on board to 373 lbs. The flight manifest signed by Pilot in Command indicated that the aircraft was loaded upto 12493 lbs. The aircraft was boarded with 14 passengers (7 females and 7 males) and the flight manifest used approved weights of 174 lbs for male and 142 lbs for female to calculate the aircraft weight. The aircraft had 1255 lbs of fuel. This particular aircraft was a short nose twin otter aircraft, with main loading in aft cabin.

The TMA seaplane operation was based on a day VFR, non-schedule and a self dispatch system. All pre-flight duties were completed by the crew. There was no ground crewman to oversee the starting and taxiing phases, and there was no requirement either.

The flight (TMC) was cleared for west bound take-off (from the water runway on Eastern side of Male' International airport) at 10.55 LT by Male' Tower. Wind was 230/09 knots. The total length of the east west runway available for take-off and maneuvering up to the seawall is approximately 1000 meters. All water runways were in use. The aircraft taxied to the east-west water runway from Trans Maldivian Airways Dock and backtracked to the end of the runway for take-off. TMC commenced its take off to Velavaru under the control of pilot in command. Air Traffic Controllers indicated there were no communication difficulties with crew of the flight.

At the time TMC got the clearance to take-off an Airbus A330-200 was on long finals (7-10 DME, MLE VOR) for runway 18 of Male' International Airport. TMC was not given any instructions to expedite take-off or altitude restrictions. A second aircraft 8Q- TMJ (DHC-6 float plane), operated by the same company was taxiing to depart to the same destination as TMC. TMJ chose to use the north-south water runway.

The Aerodrome Controllers in the tower and TMJ crew thought that the aircraft made a longer than normal take-off run.

It could be seen from a photograph (see Appendix C) taken by a passenger during take off run, that the flaps were at Zero Degrees and air speed at 70 knots

Information from the passengers indicated that the aircraft accelerated slowly. Whilst the pilots understood that the flight conditions were normal, approaching the sea wall captain realising the height of the aircraft, pulled on the controls to clear the obstacle.

Most passengers and the cabin crew reported a sound from the rear of the aircraft. One passenger confirmed seeing the co-pilot look back on hearing the sound.

The aircraft left float struck the sea wall.

### 1.2 Injury to persons

<i>Injuries</i>	<i>Crew</i>	<i>Passengers</i>	<i>Total in the aircraft</i>	<i>others</i>
Fatal	0	0	0	NIL
Serious	02 Maldivians	01 German	03	NIL
Minor	0	01	01	NIL
None	01	12	13	NIL
<b>Total</b>	<b>03</b>	<b>14</b>	<b>17</b>	<b>NIL</b>

### 1.3 Damage to aircraft

Both floats were detached from aircraft. Forward underside of the left hand (LH) float was crushed. RH float was cut off at the forward propeller cautionary line.

The RH wing was intact; however the RH propeller was detached from the A-flange (reduction gear box to exhaust case flange) of the engine.

The LH wing strut was detached from fuselage, severing the fuel line. The LH wing's forward attachment point was sheared off, while the rear attachment point was intact. The LH wing was turned upside down, with leading edge facing rearwards. All the lines connecting to the LH engine were severed.

Cockpit ceiling and left side fuselage behind captain seat was cut through a number of times.

Aft fuselage (tail section) was ruptured.

## 1.4 Other damage

The top cement layer of sea wall was crushed. The runway had the track marks of the aircraft.

## 1.5 Personnel information

### 1.5.1 Captain –

Age:	29
Nationality:	Maldivian
Gender:	Male
Type of Licence:	Airline Transport Pilot Licence (Aeroplanes)
Medical issued on:	20 August 2003
Medical expires on:	20 August 2004
Type of medical:	Class 1
Licence issued on:	05 June 2000
Licence expires on:	05 July 2004
Types flown:	Do-228 and DHC-6 (on Maldivian licence)
Hours on type:	DHC-6 3600hrs
Ratings:	DHC-6 Float Plane
Last Proficiency check:	03 May 2003
Last Flight Training on type:	03 May 2003
Last Line check:	9 November 2003
Last Emergency and Survival Equipment Check:	30 September 2003
Last Check Pilot Monitor:	14 December 2002
Results of recent periodic checks:	100% on DHC-6
Type Examination done on:	01 December 2002
Experience on the aerodrome:	Since 05 <sup>th</sup> June 2000
Total hours as PIC:	4500hrs
Total hours as SIC:	1700hrs
Total flight time:	6200hrs
Hours flown in last 24 hrs:	02hrs 49mins
Hours flown in last 07 days:	10hrs 30mins
Hours flown in last 90 days:	201hrs 48mins
Duty time in last 48 hrs:	14hrs 45mins
Rest periods in last 48 hrs:	33hrs 15mins

### 1.5.2 Co-pilot –

Age:	23
Nationality:	Maldivian
Gender:	Male
Type of Licence:	Commercial Pilot Licence (Aeroplanes)
Medical issued on:	29 April 2004
Medical expires on:	29 April 2005
Type of medical:	Class 1
Licence issued on:	30 July 2002
Licence expires on:	19 August 2004

Types flown:	DHC-6 (on Maldivian licence)
Hours on type:	1200hrs
Ratings:	DHC-6 Float Plane
Last Proficiency check:	19 August 2003
Last Flight Training on type:	12 August 2003
Last Line check:	25 August 2003
Last Emergency and Survival Equipment Check:	24 August 2003
Results of recent periodic checks:	100% on DHC-6 Type Examination done on 26 August 2003
Experience on the aerodrome:	Since 30 <sup>th</sup> July 2002
Total hours as SIC:	1400hrs
Total flight time:	1400hrs
Hours flown in last 24 hrs:	02hrs 49mins
Hours flown in last 07 days:	11hrs 18mins
Hours flown in last 90 days:	196hrs 06mins
Duty time in last 48 hrs:	05hrs 30mins
Rest periods in last 48 hrs:	42hrs 30mins

### 1.5.3 Cabin Crew –

Age:	29
Nationality:	Maldivian
Gender:	Male
Licence issued on:	20 February 2002
Medical issued on:	10 November 2003
Medical expires on:	10 November 2005
Type of medical:	Class 2
Experience:	Joined MAT on 03-12-97 and after a break from 30-11-01 to 20-02-02 joined TMA on 20-02-02
Last First Aid training on:	19 May 2003
Last Fire Fighting on:	25 February 2003
Last Life Saving on:	06 June 2003
Last Raft Demo on:	09 July 2003
Last Cabin Crew Line Training:	20 February 2002
Last Emergency and Survival Equipment Check:	19 February 2002

## 1.6 Aircraft information

### 1.6.1 General information –

Aircraft manufacturer:	De-Havilland of Canada
Model:	DHC-6-300 Twin Otter
Serial number:	434
Year of manufacture:	1974
Nationality:	Maldivian
Registration marks:	8Q-TMC
Validity of C of R:	Perpetual
Validity of C of A:	28 May 2004
Name of owner:	Ashe Aircraft Enterprises Ltd
Name of operator:	Trans Maldivian Airways

1.6.2 Aircraft History –

Total flying hours since: -  
- manufacture: 44333.59hrs  
- last periodic inspection: 51.21hrs

1.6.3 Engines and propellers –

Right engine:  
Manufacturer: Pratt & Whitney (Canada)  
Year of manufacture: 1980  
Model: PT6A-27  
Serial number: PCE-40776  
Last overhaul date: 18 September 2001  
Hours since overhaul: 2291.44 hrs  
Last check carried out: Emma #3  
Hours since last check: 53.54 hrs

Left engine:  
Manufacturer: Pratt & Whitney Canada corp.  
Year of manufacture: February 1981  
Model: PT6A-27  
Serial number: PCE-42164  
Last overhaul date: 15 July 2000  
Hours since overhaul: 2928.981hrs  
Last check carried out: Emma #3  
Hours since last check: 53.54 hrs

Right propeller:  
Manufacturer: Hartzell Propellers Inc  
Year of manufacture: not known  
Model: HC-B3TN-3DV  
Serial number: BUA26356  
Last overhaul date: 02 October 2002  
Hours since overhaul: 1608.41hrs  
Last check carried out: Emma#3  
Hours since last check: 53.54

Left propeller:  
Manufacturer: Hartzell Propellers Inc  
Year of manufacture: not known  
Model: HC-B3TN-3DV  
Serial number: BUA20681  
Last overhaul date: 03 May 2002  
Hours since overhaul: 2184.49hrs  
Last check carried out: Emma#3  
Hours since last check: 53.54 hrs

1.6.4 Fuel –

Type of fuel used: Jet A1  
Amount of fuel on board: 1255lbs

1.6.5 Accessories – No Component failed.

1.6.6 Defects – RH Fuel quantity gauge was deferred under MEL item 28 (3), category B for being inoperative.

1.6.7 Aircraft load –

Certified take-off mass:	12,500 lbs
Certified landing mass:	12,500 lbs
Take-off mass as per load sheet:	12,493 lbs

1.6.7.1 Load sheet

The load sheet served as the passenger manifest. A copy of the load sheet was retained with dispatch before take-off as required by the company Operations Manual

1.6.7.2 Payload

The payload was the aggregated weight of the pilots, the passengers and their baggage. After the accident all nine pieces of baggage in the aircraft were weighed. The items had a total weight of 411 lbs.

The weight of fuel stated on the load sheet was 1255 lbs. The tech log sheet, load sheet and the fuel bowser records correlated to one another.

Passenger weights were calculated using approved standard weights. It was observed that all the passengers were at average or below average weight.

TMC was a short nose twin otter, with main baggage loading in aft cabin.

1.6.7.3 Take-off weight

The aircraft's weight at take-off was determined using approved standard weights for passengers and the best available data for all the other weights. These figures were as follows:

<b>Item</b>	<b>Highest likely - Weight (lb)</b>
Aircraft empty weight	8168
Fuel	1255
14 passengers + 3 crew	2697
9 passenger bags	411
Total weight	12531

#### 1.6.7.4 Centre of Gravity

The centre of gravity was not calculated before take-off, since it is not a requirement by CAD. However, post accident, the centre of gravity was calculated using the centre of gravity chart available in the flight manual. It was within the prescribed envelope.

#### 1.6.7.5 Take-off distances

The distance from the line-up position to the intersection where the aircraft was supposed to have been airborne was approximately 1685ft. The performance data in the Flight Manual were interpolated for flaps at 20 degrees, deducing a run of 1400ft and a distance of 2300ft to clear a 50 feet obstacle (as per FAA AFM for Wipline 13000 DHC6 float installation supplement dated 23 December 1993).

#### 1.6.7.6 Operating speeds

The following are approximate operating speeds, expressed in Knots Indicated Airspeed (KIAS), relevant to the accident flight (FAA AFM for Wipline 13000 DHC6 float installation supplement dated 23 December 1993):-

Stalling speed (power off flaps up, propeller feathered)	67 KIAS
Minimum control speed (flaps 10)	70 KIAS
One engine inoperative best rate of climb speed	86 KIAS flaps 10
One engine inoperative best angle of climb speed	80 KIAS flaps at 10

### 1.7 Meteorological information

Meteorological report at 11.00hrs on 17 May 2004 was as follows:

Wind 230/09, Visibility 10km or more, few clouds at 1900ft,

Broken at 27000ft, temperature 31, dew point 25, QNH 1011mb.

The accident occurred during daylight; one hour before noon (12pm).

The time of day, visibility and cloud cover did not contribute to the accident.

### 1.8 Aids to navigation

VOR and GPS were serviceable at the time of accident.

Navigation was not a factor in this accident.

### 1.9 Communications

Two VHF sets: COM 1 – set on company frequency

COM 2 – set on tower frequency

Both the sets were serviceable at the time of departure.

No communication problem was reported

## **1.10 Aerodrome information**

Aircraft took off from water aerodrome located at the eastern side of the main land aerodrome.

Runway length Available approximately: 3250 ft.

Obstruction: Seawall at the impact point was approximately 3ft above sea level at the time of accident

Orientation: 30/21(commonly called east- west runway).

Water Runway condition: Calm

## **1.11 Flight Recorders**

The aircraft was not fitted with any flight recorders and none was required by the regulation. (The aircraft is type certified below the weight category 5700kg; Refer MAR Series-C9, 4.2)

## **1.12 Wreckage and impact information**

### **1.12.1 Accident site**

The first point of contact was with the sea wall in a north westerly direction (309 degrees heading). The impact damage to the seawall was 11ft wide. There was, also, scrape marks on the sea wall 15 ft north of first impact point.

Float aft tie bar was lying in the sea, in the vicinity of impact mark. Some parts of float stairs, were also found in the sea.

Left Hand float was lying on the seawall, pointing west, some 20 feet north of first impact mark, with the front underside crushed in.

The second impact mark was on the ground 104 ft west of the seawall. Two parallel marks on the ground running north westerly direction (320 degrees) was observed The first mark was up to main asphalt runway, while the second parallel mark was up to the location where the right hand float was lying.

The right hand float was, lying approximately half way from the initial contact at sea wall to the final wreckage site along the line of aircraft movement after impact with seawall, pointing north westerly direction with the front end cut-off. The front end was cut off just before the propeller caution marking.

There was a deep cut on the ground along the path of aircraft movement after impact.

The right hand propeller was lying close to the cut-off front end of right float. It was sheared off from the reduction gearbox flange.

The right hand propeller had sustained the following damage:

Blade No. 1:

Slight leading edge damage was observed. The top portion of the blade tip was bent at the 15 degree angle with a severe tear also present at this location. The first quarter of the



blade (from the tip) was severely bent at 45-degree angle, with the second quarter of the blade being bent at 30 degree angle.

Blade No.2:

Leading edge damage and tearing was observed. The top portion of the blade tip was slightly bent at the 15 degree angle. The first one third of the blade (from the tip) was bent at 10-degree angle, with a severe tear and dent also present at this location.

Blade No.3:

The top portion of the blade tip was slightly bent at 15 degrees angle. The first half of the blade (from the tip) was severely bent at 90-degree angle.

The main wreckage lay on the asphalt runway about 100 feet of the seawall, in a southerly direction (190 degrees). The cockpit ceiling of the aircraft was cut through. The left wing was turned upside down, with leading edge pointing towards rear. The leading edge attachment point left wing was sheared, while the wing was attached at the rear attachment point. All the LH engine control cables were torn apart. The left wing strut was sheared off. Right hand wing and wing strut were intact, but the fuel line was sheared at fuselage – wing strut attachment. Aft fuselage was damaged with an open hole. The following damage was sustained by the left propeller:

Blade No. 1:

Slight leading edge damage was observed. The top portion of the blade tip was bent at 90 degree angle.

Blade No.2:

Slight leading edge damage was observed. The top portion of the blade tip was bent at the 170 degree angle. The first quarter of the blade (from the tip) was severely bent at 45-degree angle, with the second quarter of the blade being bent at 30 degree angle.

Blade No.3:

Slight leading edge damage was observed. The top portion of the blade tip was bent at 45 degrees. The first quarter of the blade (from the tip) was bent at 15-degree angle.

#### 1.12.2 Engine Instruments

All engine gauges were checked and there was a significant difference between the left and right hand gauges (See Appendix A) The engine gauges after impact reveals that the left fuel flow showed 400 lbs/hrs and left oil pressure gauge 90 psi, where as right fuel flow showed a lower value of 100 lbs/hr and right oil pressure 40 psi. All the other engine gauges showed zero readings.

### 1.12.3 Fuel Selection

Before the PIC came out of the cockpit he had switched off the boost pumps and fuel emergency switches. However during the removal of engines the fuel shut-off valves were found in open position.

## 1.13 Medical and pathological information

1.13.1 Examinations were performed on all of the occupants of the aircraft. There was no evidence of any pre-existing disease, alcohol, drugs or any toxic substance in either of the pilots which may have caused or contributed to the cause of the accident.

The aircraft PIC sustained two cracked ribs. There were severe cuts on the neck and shoulder blades of the co-pilot. Another passenger at the front row had injuries to her head.

## 1.14 Fire

There was no evidence of fire before or after impact.

## 1.1.5 Survival Aspect

Aircraft came to a halt on the land runway, with no fire. All the passengers had their seat belts on. The flight crew had their shoulder harness and lap harness engaged, however the PIC shoulder harness was cut off.

Cabin crew initiated the evacuation of passengers who were uninjured. The TMA personnel working on the west side of runway arrived at the scene first and removed the co-pilot, who was blacked out. The PIC walked out of the aircraft by himself and was helped on to a vehicle by the Rescue and Fire Fighting Service (RFFS) personnel. The passenger with serious injuries lay in the aisle. RFFS and TMA personnel helped to remove her out of the aircraft.

Fuel leaked from the, severed fuel lines. RFFS personnel sprayed foam, to prevent an aircraft fire.

## 1.16 Tests and research

A light bulb analysis of all the caution lights was carried out. The analysis revealed that the stall warning light was on during the time of impact. (See Appendix D)

## 1.17 Organizational and management information

The company is a Civil Aviation Department (CAD) approved Air Operator Certificate Holder. Operations were conducted in accordance with CAD approved Operations Manual.

Regular inspections and periodical flight checks were conducted on the company and crew respectively by CAD to verify compliance and competency. The company had undergone a ramp check on 16<sup>th</sup> May 2004. A documentation inspection was carried out on 28<sup>th</sup> to 29<sup>th</sup> December 2003.

The company has an approved CRM manual and a Flight Safety Manual. The PIC involved in this accident was the approved Safety Pilot.

### **1.18 Additional Information**

None

### **1.19 Useful or Effective Investigation Techniques**

None

## **2. ANALYSIS**

### **2.1 General**

#### **2.1.1 Flight reconstruction**

As there was no regulatory requirement for the carriage of flight data or cockpit voice recorder, the flight path reconstruction is not precise. The flight path, thus, was constructed from eyewitness accounts and location of the wreckage before and after the impact as illustrated on the diagram at Appendix B.

Eye witness accounts confirmed that the aircraft went to the end of east-west water runway for take off. The wind was at 230/09 knots. The aircraft heading was 301 degrees, which would induce a head wind of 3 knots and a cross wind of 8.5 knots. The crew had sufficient water run for a normal take off with the prevailing wind and aircraft loading condition.

The decision to choose EW runway was not elicited by wind condition, although operationally it was a reasonable choice based on the number of aircraft movements.

#### **Wreckage analysis**

The aircraft was facing approximately 90 degrees left to the path of original flight with both floats and its attachments and right hand prop detached. The left hand wing was twisted with engine pointing rearwards with propeller intact. The cockpit was badly damaged with impact marks from left hand propeller.

The left hand float was lying on the sea wall approximately 20 feet right of seawall impact mark and pointing to the direction of aircraft movement during the time of impact. The initial event leading to the accident was the impact of left hand float with sea wall. This caused the left float and the wing strut attachment to fuselage to be detached. This event induced sufficient force on the leading edge attachment of wing to cause the detachment.

Modification (mod reference number 6/1752) was carried out on TMC's wing, a steel rod at the trailing edge of wing running span wise along the wing and holding firm the fuselage, to prevent the wing coming forward and the propeller hitting the cockpit in case the wing attachment fails. The aircraft wing did not get detached fully but made a single point pivot at the trailing edge of wing. The upward lift on the wing caused the wing to rotate upwards at the pivot point, in the event all the fuel lines and other control wires got

sheared. The fuel starvation caused the engine to reduce power and cease completely later in the event. As the wing moved up wards it is suspected that the power reduction made the wing come downwards to the weight of engine and since it's attached at single point wing is likely to rotate in any direction. As the wing came down with some power on engine, the prop damaged the cockpit and hence injured the crews. The tips of all the three Left hand prop blades were damaged; with one blade showing signs of metal scratch marks.

The ground impact mark reveals that the right hand float was intact at the time of impact with ground and in a later phase the right hand float detached. As the float struck the ground causing it to rise and it was struck by the RHS prop which cut off the frontal portion, Due to high impact force of float, the right hand prop got detached too. The right hand float and the right prop were lying close to each other on the ground. The right hand prop was sheared off from the gearbox and one of the blades was bend half span wise while other two blades tips were damaged with one detached.

All the control cables of aircraft were inspected at wreckage site. There were no signs of cable pre impact failures. Any cable that was detached was either cut off due to prop strike or pulled off due to left wing turning. Hence all the cables were intact and functioning before the aircraft impact.

The aircraft was in the normal take-off configuration as far as propeller and power levers were concerned. However the flaps actuator position and the right elevator trim tab indicated that the flaps position was between 0 and 10.

Based on empirical evidence and wreckage analysis it was determined that-both engines were producing power at impact. This is confirmed by the fact that most of the damage done to the aircraft was by the propeller.

#### 2.1.3 Emergency Fuel Selector

Both emergency fuel selector valves were found in the ON position in the cockpit. However, on both the engines the emergency fuel selector valve was found to be in OFF position. This meant fuel to engines was not cut by the emergency valves. This might have been due to power being cut off as the left propeller cut into the cockpit ceiling.

#### 2.1.4 Engine gauges

The engine gauges after impact reveals that the left fuel flow showed 400 lbs/hrs and left oil pressure gauge 90 psi, where as right fuel flow showed a lower value of 100 lbs/hr and right oil pressure 40 psi. All the other engine gauges showed zero readings. The above indication reveals that left hand engine was running at sufficient power at the time of impact. The right hand engine discrepancy can be explained from the detached prop. The detached prop would reduce considerable load on a running engine, which might show a lower fuel flow and fuel pressure.

Master switch was in the 'OFF' position.

## **2.2 Flight Operations**

### 2.2.1 Crew Qualifications

The crew were holding valid licences, with valid medicals and were trained in accordance with the approved training manuals. Pilot Proficiency Checks were done annually (as required by regulations for VFR operations) and they were within the validity period.

### 2.2.2 Operational Procedures

Operational procedures require the flight crew to select 20 degrees flaps for take-off.

### 2.2.3 Weather

Not a contributing factor.

### 2.2.4 Air Traffic Control

Not a contributing factor.

### 2.2.5 Communication

Not a contributing factor.

### 2.2.6 Aids to Navigation

Not a contributing factor.

### 2.2.7 Aerodrome

Not a contributing factor.

## **2.3 Aircraft**

### 2.3.1 Aircraft Maintenance

The aircraft was maintained in accordance with the approved maintenance schedule from Civil Aviation Department. All maintenance paper works were complete and up to date. These works were completed within the prescribed limits, except for an over reading fuel gauge which was deferred in accordance with the approved MEL.

### 2.3.2 Aircraft Performance

The aircraft is capable of performing all maneuvers with the correct configuration set. This accident was not caused by a degradation of performance.

### 2.3.3 Mass and Balance

The aircraft loading was not a factor in this accident. Though, a lighter aircraft could have had a better climb rate.

#### 2.3.4 Aircraft Instrumentation

The aircraft instruments were not a contributing factor in this accident, since all aircraft instruments were functioning properly prior to accident

#### 2.3.5 Aircraft Systems

The aircraft systems were not a contributing factor in this accident, since all aircraft systems were functioning properly prior to accident

### 2.4 Human Factors

The pilots stated that they followed the check list. However this cannot be verified by any other means. Based on the wreckage analysis the flaps were not selected for take off as specified in their checklists.

### 2.5 Survivability

#### 2.5.1 Rescue Fire Service Response

Rescue and Fire Service was on site within minutes of accident. They sprayed a foam blanket over the fuel spill to prevent fire on aircraft.

#### 2.5.2 Analysis of injuries

The injuries sustained by the flight crew were due to left hand propeller cutting into the cockpit. Two passengers sustained injuries due to impact.

#### 2.5.3 Survival Aspects

Since the aircraft came to a halt without any fire and with minimal damage to cabin, all the passengers and cabin crew survived with minor injuries. Both the flight crew got injured badly, because of the propeller strike through the cockpit.

### 2.6 Other factors

#### 2.6.1 Pre take-off events.

The two pilots and cabin attendant performed all the routine tasks such as pre-flight inspection, determining loading, and removal of the baggage as it exceeded the weight and finally embarkation of the passengers. Consequently there were no witnesses to engine starting apart from the persons on board and crew who did not recall any starting difficulties or unusual events.

The cabin crew reported that there was no audible or visible aircraft abnormality before take-off; he reported having felt two bumps, which he thought, were two waves (he also mentioned that it was unusual to have waves at that lagoon but he did not think of it at that time).

The aircraft was not required to have a flight recorder fitted as it was below the weight category for such a requirement. The investigation was thus hampered by the lack of any

record of the pilots' conversation including routine and emergency checklist actions. Such a record would have added greatly to the understanding of this accident.

### 2.6.2 Flap position

The photograph taken by a passenger onboard whilst on take-off run or just after airborne (70 knots) revealed the flap lever position and flap indicator at 0 degrees (Appendix C). Although the Twin otter flight manual and company SOPs require flap to be at 20 degrees for take-off. The checklist taken from the aircraft required the flaps to be SET in taxi checks. The flaps were found in the up position on examination of the flaps after the aircraft crashed.

The principal factors relevant to the choice of flap setting are runway length, take-off weight, and obstacles in the departure direction. The aircraft has a shorter take-off ground roll with flaps extended and climb performance is improved. Runway 30 is twice longer than the calculated length required by a Twin Otter Seaplane at maximum take-off weight to accelerate to take-off speed. Take-off with the flaps retracted is a major causal factor to the accident since climb performance had degraded significantly.

## 2.7 Before the initial impact

### 2.7.1 The take-off

According to the eyewitnesses and the ATC controllers, the aircraft made a longer than normal take-off run.

The runway distance from the line-up position to the intersection where the aircraft is supposed to have been airborne is approximately 1685ft. The performance data in the Flight Manual were interpolated for flaps at 20 in predictions of a ground roll distance of 1400ft and a total distance to 50 feet height of 2250ft.

### 2.7.2 The initial climb

Based on the available information the commander took off with the flaps UP, instead of doing the expected climb rate aircraft started sinking. The PIC saw he was closing on sea wall and pulled the control column to avoid hitting it but as he did so it is probable that the aircraft stalled; light bulb showed that stall warning had come and hit the left float against the seawall.

## 2.8 The initiating event

### 2.8.1 The position of the aircraft when the noise was heard

Passengers were uncertain precisely when they heard the noise, but it was probably when the left float hit the sea wall.

### 2.8.2 The aircraft height when the initiating event occurred.

The aircraft was just about 3ft high. This is determined by the position of impact on the seawall. The impact was on the top of sea wall not on the sides. The sea wall above the sea level at that time was determined to be 3ft.

## **2.9 The stall**

The stall speed in level flight was in the order of 75 KIAS with flaps UP and any attempt to turn or increase angle of attack was likely to stall the aircraft and lead to an abrupt loss of control. Hence the stalling would have occurred when the PIC pulled the controls to avoid hitting the seawall.

## **2.10 Condition of the engines in flight**

### 2.10.1 The engines

Both engines were removed from aircraft and subjected to a visual and borescope inspection. The visual inspection revealed that the both engine had similar kinds of damage. The exhaust casing cover showed signs of heavy torsion, indication the props were running at the time of impact. The PT blades were in good condition but they were stuck to rotate due to impact. Compressor blades on both the engines were running freely and were in good condition. P3 and P4 line showed no indication of leakage. Borescope inspection revealed all the CT blades were in good condition. From the subjected inspections there was no indication of engine malfunctioning.

### 2.10.2 Engine instrument indications

After PIC realised that aircraft was not taking off, he immediately looked at the instrument panel and noticed no abnormal indication from the engine instruments. He could not account for the abnormality.

## **2.11 Summary**

The experienced and competent commander was confronted with an unenviable situation created by his own doing at a critical stage of his flight. Time for him to make the correct diagnosis and to take the correct action was short. An attempt was made to clear the seawalls which led the aircraft to stall but not abort the take off. The commander was unable to bring the wings level before crashing onto the seawall and only left float hit the sea wall. He however took all precautionary measures to counter any outbreak of fire upon crashing before he came out of the cockpit.



## **3 CONCLUSIONS**

### **3.1 Findings**

#### ***Operation of the flight:***

- The commander was qualified, well experienced, competent, adequately rested and medically fit to conduct the flight.
- The second pilot was adequately rested, medically fit and competent to perform the role of 'second pilot' as specified in the Company Operations Manual
- A copy of the load sheet was deposited with the dispatch before departure thus leaving an accurate record of the aircraft's weight and technical log details before flight was available because tech log was recovered from the wreckage.
- The calculation of aircraft weight indicated an excess of 30lb (12500lbs) but this is with approved standard passenger weight. The passengers on the flight were determined to be average or below average passengers in weight as seen by the investigation team. This would not have prevented the aircraft from climbing.
- The aircraft was serviceable at take-off
- Wing flaps were not used for the take-off
- Existing regulations did not require the aircraft to be fitted with flight recorders. The lack of any recorded data about the aircraft's performance or the pilots' conversations deprived the investigation of essential factual information.
- PIC did not realise that they were doing a flapless take-off.

#### ***Collision and loss of control:***

- PIC pulled at controls to avoid the sea wall which resulted in aircraft stalling and left float hitting the seawall
- Post accident inspection of engines and light bulb analysis did not reveal any evidence of a problem with the engines.
- Both engines were producing power at impact
- The modification on the wing did not prevent the propellers striking the cockpit.
- Emergency fuel shut off selections were ON but on examining the engines it was found that both valves were in open position.

### **3.2 Causal Factors**

The investigation identified the following causal factors:

The crew failed to select the flaps to the standard 20 degrees as required.

The crew failed to abort the take-off.

The Pilot-in- Command did not take any action to abort the take-off as the aircraft approached the sea wall.

## **4 RECOMMENDATIONS**

The following recommendations were made:

### **4.1 Recommendation 1**

The checklist be amended to repeat vital checks before every stage e.g. taxi, before take-off, etc.

### **4.2 Recommendation 2**

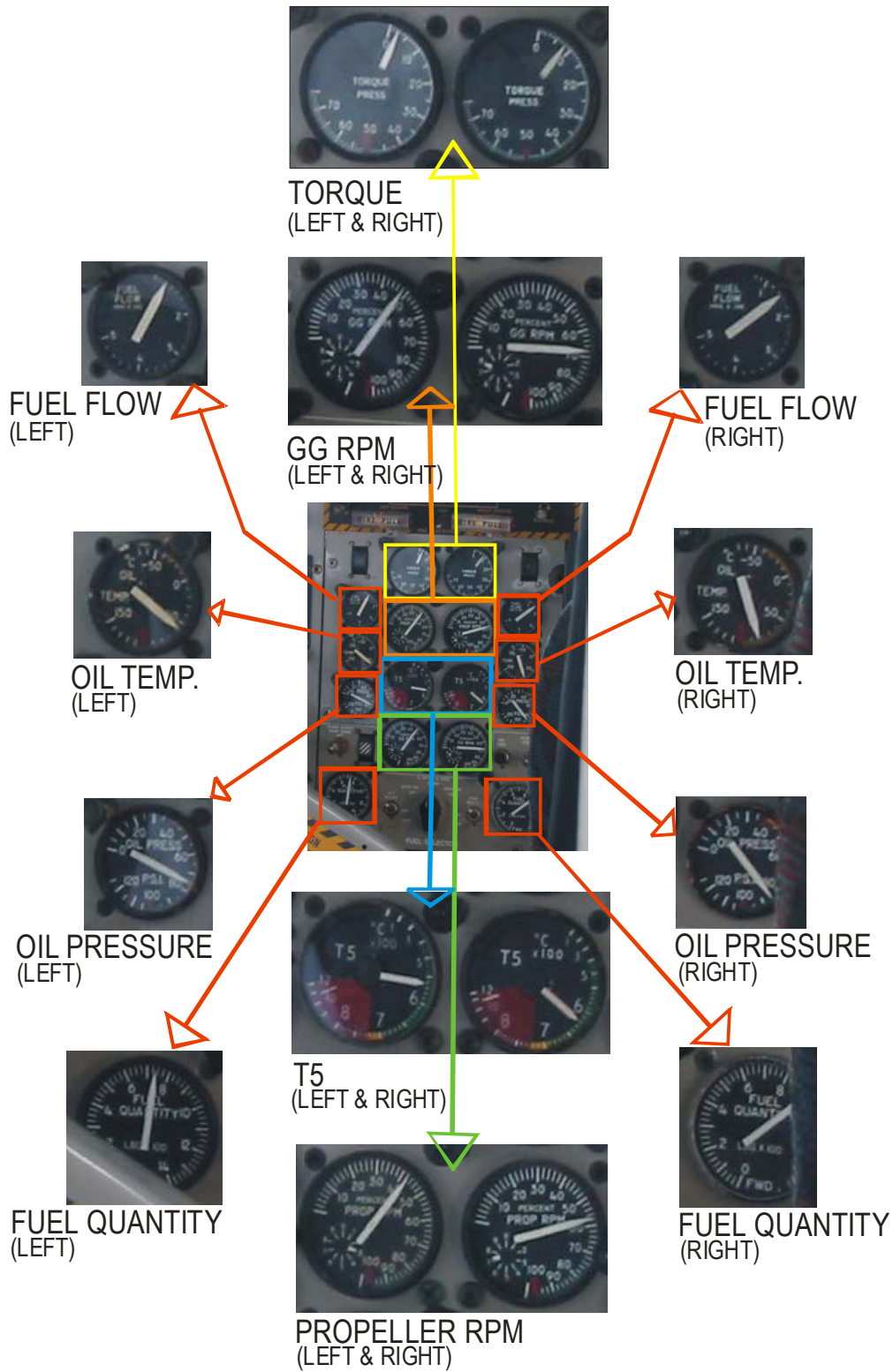
Review the performance of DHC-6 seaplanes, with wipline floats, in all worst possible configurations, critical runways, wind conditions and verify these practically as much as possible, as wipline float was not part of the initial Type certification.

### **4.3 Recommendation 3**

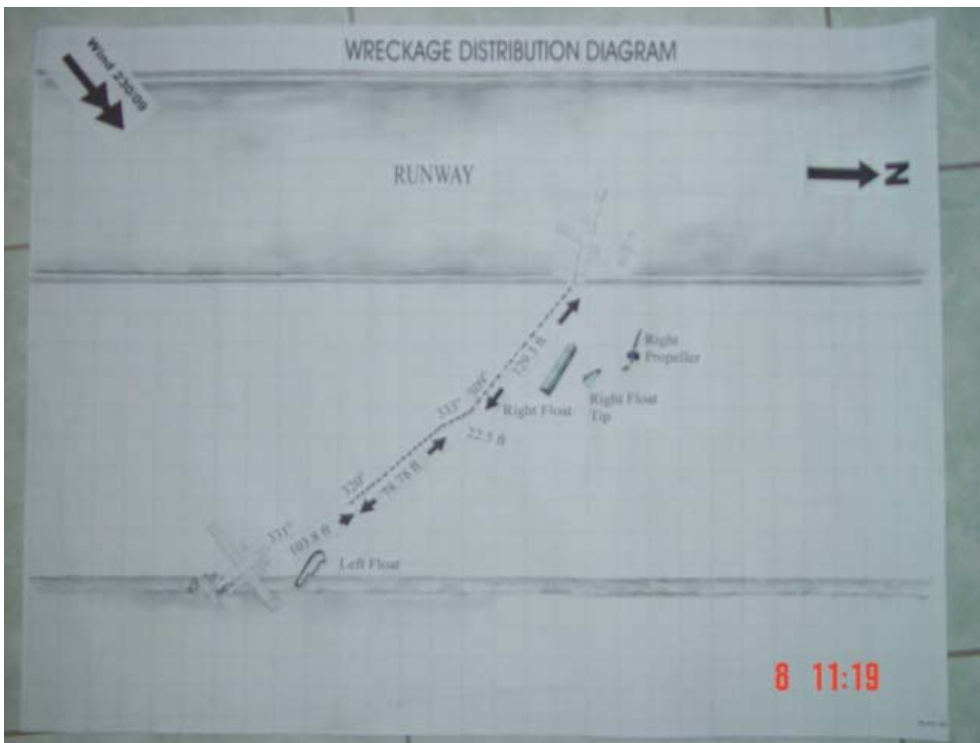
The CAD should re-examine the criteria for the carriage of flight recorders by aircraft, which have in force a certificate of airworthiness in the Transport Category (Passenger) and are certified to carry more than 9 passengers with a view to requiring all aircraft, whether piston or turbine powered, to carry at least a Cockpit Voice Recorder.

August 15, 2004

# Appendix - A



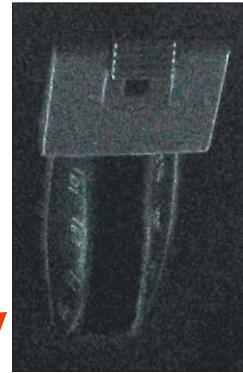
# Appendix - B



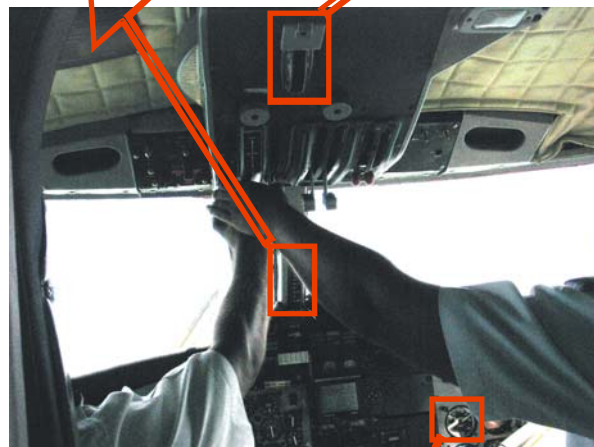
## Appendix - C



Flap Indicator



Flap Lever



Airspeed Indicator

## Appendix D

### 8Q - TMC caution lights bulb analysis

	BULB 1		BULB 2	
	HOT	COLD	HOT	COLD
L. Generator Over heat (deactivated)		X		X
L. Generator		X		X
L. Engine Oil Pressure		X		X
Doors Unlocked (deactivated)		X	<i>No bulb</i>	
Boost Pump 1 Aft Pressure		X		X
Aft Fuel Low Level	<i>No bulb</i>		X	
Low Pressure (deactivated)	No bulbs - deactivated			
Boost Pump 2 Aft pressure		X		X
L. 400 cycle		X		X
Reset Props		X		X
Boost Pump 2 Fwd Pressure		X		X
R. 400 cycle	X		X	
Duct Overheat (deactivated)	No bulbs - deactivated			
Boost Pump 1 Fwd Pressure		X		X
Fwd Fuel Low Level	X		X	
R. Generator Overheat (deactivated)	No bulbs - deactivated			
R. Generator		X		X
R. Engine Oil Pressure		X		X
Stall warning light	X		X	

All the bulbs were tagged and removed on 26th May 2004, in the presence of accident investigation committee from wreckage site