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## **REPORT OF THE ACCIDENT TO DORNIER 228 AIRCRAFT (9M-PEQ) AT MALE' INTERNATIONAL AIRPORT ON 18TH OCTOBER 1995**

### **INTRODUCTION**

Maldives is a signatory to the Convention on International Civil Aviation (Chicago 1944), which established the International Civil Aviation Organization. Article 26 of the Chicago Convention obligates the governments of countries that are signatory to the Convention to conduct investigations into aircraft accidents in their territories which involve aircraft of other countries which are signatories to the Convention.

In conducting the accident investigation the fundamental objective of the investigation is the prevention of aircraft accidents and incidents.

It is not the purpose of this activity to apportion blame or liability. The sole purpose of the exercise is the maintenance and enhancement of flight safety.

### **SYNOPSIS**

The accident occurred during the day in excellent visibility at Male' International Airport and notification of accident was received at the Civil Aviation Department at 9.46 LT. The investigation was underway from 10.55 LT onwards.

#### **Participants to the investigation were:**

- |    |   |                                |
|----|---|--------------------------------|
| 1  | Director of Civil Aviation, Maldives            | Mr Abdul Razzak Idris          |
| 2  | Director, Air Safety / Maldives CAD             | Mr Mahamood Razee              |
| 3  | Senior Flight Operations Officer / Maldives CAD | Capt Mohamed Mansoor           |
| 4  | Deputy Director, ATM / MAA                      | Mr. Ahmed Nazim                |
| 5  | Chief Pilot / Air Maldives Ltd                  | Capt Hussain Sham              |
| 6  | Engineering Manager/Air Maldives Ltd            | Mr Ismail Rasheed              |
| 7  | NSS   | Lieutenant Mohamed Sadiq       |
| 8  | NSS   | Staff Sergeant Ibrahim Khaleel |
| 9  | Tech Investigator / Dornier                     | Mr Werner Vestner              |
| 10 | Field Service Engineer/Allied Signal            | Mr William J Begue, Jr         |
| 11 | Aircrew Examiner/Malaysia DCA                   | Capt Abdul Rahman bin Osman    |
| 12 | Quality Assurance Engineer /Pelangi             | Mr Zulparqeen Ahmed            |

The accident occurred during the landing roll; whence the aircraft abruptly turned right, left the runway; struck the sea-wall and somersaulted into the adjacent lagoon and floated belly up. All five passengers and three crew were rescued, with one passenger having rib injuries and minor injuries to two others.

As per the report the accident occurred due to landing at 20° angle to the left of the centerline and over application of right rudder to get the aircraft onto centerline and also failing to get the power levers to ground idle by the Co-pilot who was flying at the time of landing.

Identified, in the report, as causal factors are;

- a) the 'over correction' of the handling pilot to the prevalent cross wind, leading the aircraft to land at 20° to the centerline.
- b) the failure of the PIC to take controls on landing when the aircraft touched at 20° angle to the

centerline and continuing in that direction until very close to the runway edge.

c) over application of right rudder to get the aircraft onto centerline and subsequently failing to get the power levers to ground idle.

d) the lack of a Crew Resource Management (CRM) programme in the company had meant that the pilots, albeit friendly, did not have a harmonious attitude towards one another, particularly the Captain to the Co-pilot.

## 1. FACTUAL INFORMATION

### 1.1 History of the flight

Air Maldives flight L6 3312, on a regular scheduled public transport flight departed from Kadhdhoo Airport (153300N, 0733045E) at 0403Z and landed at Male' International Airport (041126N, 0733201E) at 0443Z.

The flight was conducted on a Dornier 228-212K, registration 9M-PEQ with 02 pilots, a cabin attendant and five passengers on board. Passengers were seated between rows 4 and 6 inclusive.

The flight was cleared for an ILS approach to Male' International Airport, at 0433Z. The flight obtained clearance to land on runway 36, (reported wind 270/11 knots) at 0443Z.

The flight from Kadhdhoo to Male' was uneventful until landing, and during the flight both pilots were in good spirits.

The aircraft landed at about 90-95 knots and touch down about 600m beyond the threshold of the runway 36, about 20° to the centre line; to the left of the centre line. On touch down the aircraft moved to the left of the centre and at the nearest point was 2.7m from the edge. The handling pilot (Co-pilot) applied right rudder to get the aircraft onto the centre line and then tried to get the power levers to ground idle. The aircraft abruptly turned to the right and veered off the runway, traversing through the sand and the grass and crashed on to the sea wall at an angle; at which point the nose was pointing approximately ESE. The nose landing gear collapsed, followed by the LMG and then the RMG and the aircraft flipped on its back into the lagoon adjacent. The aircraft lay about 78m from the sea wall (measured parallel to the centre line).

The accident occurred in day light in good visibility. The local time was 0944 (0444Z).

### 1.2 Injuries to Persons

	Crew	Passengers	Other	Total
Fatal	0	0	0	0
Serious	0	1	0	1
Minor	0	1	0	1
None	3	3	0	6
<b>TOTAL</b>	<b>3</b>	<b>5</b>	<b>0</b>	<b>8</b>

### 1.3 Damage to Aircraft

The aircraft landed on runway 36, veered to the right and ran off the runway; struck the sea wall and somersaulted into the eastern lagoon of the airport. .



The aircraft sustained substantial damage to the landing gear, nose and fuselage due the crash, and deemed a write-off. Propellers, engines other damages due to ingress of water into electrical and avionics and instruments



Fig 1. 9M-PEQ, salvaged from the sea.

### 1.4 Other Damage

Only slight damage to the sea wall at the point of impact of landing gear.

### 1.5 Personnel Information

	<b>Captain</b>	<b>Co-pilot</b>
Sex	Male	Male
Age	25 years	21 years
Licence Number	ATPL 021	CPL 035
Licence Category	ATPL	CPL
Medical Certificate	Class One	Class One
Medical Validity	15 July 1996	30 August 1996
Licence Validity	17 July 1996	09 Sept 1996
Proficiency Check	11 July 1995	18 August 1995
Total Hours	3152	226
Total on type	2948	061

No tests were carried out following the accident on the crew for presence of intoxicants, drugs or narcotics. The reason for this being non-availability of alcohol to locals. All crew under went a general medical check-up following the accident and was ruled satisfactory.

### 1.6 Aircraft information

#### 1.6.1 Significant particulars

Registration	9M-PEQ
Manufacturer	Dornier GMBH
Model	DO 228-212K
Serial Number	8213
Country of Manufacture	Germany
Year of Manufacture	1992
Engines	Garrett TPE 331
Engine type	Turbo propeller engine
Certificate of Registration <b>Holder:</b>	Pelangi Air Sdn, Bhd - Malaysia
No:	M.698 (Malaysia)
Issued :	08 October 1992
Aircraft Operator	Air Maldives Limited - Maldives
<b>Certificate of Airworthiness</b>	
No:	M.602 (Malaysia)
Issued On:	08 October 1995
Validity:	07 October 1996
Last Maintenance Carried out:	16 October 1995
Total airframe hours	3857:09 (up to 16 October 1995)
Last CMR carried	18 September 1995
Next CMR due at:	16 January 1996

### 1.6.2 Weight and Balance

Aircraft maximum take of weight 9MTOW)	6400 kg
take of wight	5399 kg
landing weight	5149 kg
zero fuel weight	5559 kg
Centre of Gravity	26% nose up

### 1.6.3 Aircraft history and significant events

The aircraft maintenance was conducted by Air Maldives and controlled by Pelangi Air of Malaysia under a Continuing Maintenance Program. The aircraft contained no known defects and all required maintenance had been carried out accordingly. The last maintenance was called up and carried on 16 October 1995 and had a valid CMR until 16 January 1996. All Airworthiness documentation and work had been completed.

The flight took off from Khadhoo with a payload of 571kg, a fuel loading of 870kg and the calculated landing weight of 5149kg. The aircraft centre of gravity was 26% (nose up). The aircraft loading and performance did not play a role in the accident. The fuel used in the aircraft was Jet-A1, which was uplifted at Male' International prior to the first leg, i.e, Male'/Kadhdhoo. No refuelling available at Kadhdhoo and this operation does not require refuelling at Kadhdhoo.

### 1.7 Meteorological Information

Weather observation	Male' 0400 UTC
Wind	260° at 09kts
Visibility	More than 10km
Clouds	Scattered at 1800ft Scattered at 12,000ft Broken at 27,000ft
Temperature	30°C
Due point	25
QNH	1013

### 1.8 Aids to Navigation

The airport at which the flight landed, the destination aerodrome, has a serviceable ILS, DVOR and DME which were operational at the time of accident.

### 1.9 Communications

The aircraft was initially cleared for an ILS approach under VFR under advisory control of the Male' Tower. The aircraft remained in VHF contact with Male' Area Control Center and later Male' Tower.

### 1.10 Aerodrome Information

The last aerodrome of departure was Kadhdhoo, a licensed aerodrome of code 2B. The aerodrome at which the flight landed was a licensed airport, of 4E with a RFFS category of 9.

### 1.11 Flight Recorders

The aircraft was fitted with a 4 channel Cock-pit Voice Recorder (Sunstrand AV557D, S/N 475) as per Maldivian Airworthiness Requirements, MAR Series C 09.

The CVR is installed on the rear avionics rack frames 29/30. It was recovered on the day of the accident and was in good condition.

From the CVR reading, the reported wind was 270/11 knots when the aircraft was cleared to land.

During the final approach it was evident that the Captain Ahmed Shareef was providing guidance and continued to comment on the handling pilot (Co-pilot) manouvers and instructed him along the way.

Following the landing (able to hear the noise) by the utterance of first the Co-pilot and then Captain Ahmed Shareef (oh shit! oh! fucking shit) it was clear that something went wrong. No abnormal sounds or warning horns were heard at that point. A screeching sound was heard as the aircraft left the runway onto the dirt and grass, followed by a thud (sound of impact) and then a squeal. This appears to be the master warning combined with the ELT.

### 1.12 Wreckage and Impact Information

The aircraft after abruptly turning right, left the runway onto unpaved dirt surface.



Fig 2. Sea-wall, caused the aircraft to somersault

This area, about 50m to the sea wall, was loose sand, with pebbles and covered with some grass and a lush creeper of about 6 to 8 inches in height. The sea wall was constructed with coral boulders covered with cement mortar and was about 45cm above ground. The ground (dirt surface) was uneven, at the point of impact of NLG there was a slight ramp. The aircraft struck the sea wall in a east-south-east direction nose wheel first, which collapsed rearwards (at frame 7) on impact.

The wheel hubs of both the bogey disintegrated on impact and some pieces of the hub were recovered from the bottom of the lagoon.

The port propeller was damaged beyond repair with all four blades bent due to impact with water while the engine was still producing power.

It was evident that the RHS engine had significant FOD ingestion, with extensive damage to the impeller. A clear red paint mark was evident at the engine inlet and two clear indentation were also on the inlet. The red paint mark was of the same width of that of the creep marks on the wheels.



Fig 3. Point of first impact with sea-wall, NLG

The second point of impact was the left main landing gear which was extensively damaged. Part of the cowling and the torque link was on the sea wall. Several small pieces of landing gear cowling were strewn at the impact point. The final point of impact was the right main landing gear which after striking with sea wall was bent outwards. The aircraft after hitting the sea wall flipped belly up crashed into the lagoon about a one hundred feet from the wall in an inverted position, left wing first.



The RHS propeller had no warping but it had cut through the fuselage and strike marks indicate more than one strike.

Nicks were also present at blade tips. All wheel tires indicate even skids marks on all sides; no scraping was evident. The fuselage did sustain damage due to impact with sea wall and subsequently with the water.



Fig 4. Final impact with sea-wall, RHS, MLG.

The aircraft sustained additional damages particularly on the fuselage, due to the slinging of the aircraft during salvage operation.

The salvage operation further aggravated such damage. The fuselage was bent inwards forward of the right wing. The left hand power lever cable run and pulley assembly located at the leading edge of left wing root was severely damaged during the salvage of the aircraft.

### **1.13 Medical and pathological Information**

All passengers sustained slight abrasions and bruising. One of the passengers sustained multiple abrasions and a rib fracture; and another passenger was briefly admitted in hospital with suspected intro-abdominal injury; but later released.

### **1.14 Fire**

There was no fire at any stage.

### **1.15 Survival Aspects**

Immediately following the crash, eyewitnesses mostly Air Maldives employees (about 4) rushed to the scene of the accident. The airport fire and rescue services were at the site at 9.46 (LT) and began the rescue operation, as there was no fire.

The airport fire and rescue service was joined by the National Security Service who jointly conducted the rescue operations.

All passengers had their seat belts on and as the aircraft struck the sea wall fell in to the sea in an inverted attitude, the force of the impact transmitted to the passengers were greatly reduced.

There was no failure of seat attachments or seat belt attachments.

Out of the five passengers three were led out by the cabin attendant through the main passenger door. Two passengers egressed from the RHS emergency door. The Captain got out through his door and the co-pilot, broke the window on the RHS and evacuated himself.

The lagoon was clear and about 2.3m deep. Rescue efforts were slightly impeded by too many souls, other than the designated personnel who were engaged in the rescue effort. Also there was some confusion, as two of the passengers were servicemen and were in uniform and the rescue team from NSS were also in same uniform.

### **1.16 Emergency Services and Search and Rescue**

As the accident occurred on a bright, sunny day, several onlookers rushed to the scene of the crash, which did hamper rescue operations. The airport rescue services were at the scene at 9.46 (LT) and the Emergency Operations Centre was in operation by 0958 (LT). As there was no fire or potential fire, rescue was undertaken straight away. The crash site being close to the airport greatly assisted in the rescue effort. However, no special floatation equipment, except the life jackets worn by the passengers, was used.

Rescue operations was assisted by the service personnel from the National Security Service. Rescue operations were fully completed by 10.55(LT)

### **1.17 Tests and Research**

From the field findings, measurements were fed to a computer programme at the manufacturer's facility to determine the brake distance acceleration. This was useful as there were some indications of a possibility that the crew may have attempted to take-off again.

However, from the analysis it was determined that at the point of impact with the sea-wall, the

aircraft was at flight idle.

### 1.18 Additional Information

The understanding as per pilots, of the company policy with regard to allowing co-pilots to fly, take-off and land was to encourage it, provided cloud ceiling was above 500 ft, visibility above 10 km and crosswind less than 15 knots. There was no laid down requirement based on pilot's experience.

### 1.19 Useful or effective investigation techniques

No special techniques were in use.

## 2. ANALYSIS

All aircraft maintenance and airworthiness documentation indicate that maintenance and inspection had been carried out in accordance with pertinent regulations and the aircraft was airworthy.

The documentation, including licences, ratings and checks of flight and cabin crew were valid and flight time limitations were as per relevant regulations.

All indications are that up until landing all procedures including company requirements had been largely followed. The detailed guidance given by the Captain to the co-pilot at the final approach, appear to be in excess, considering that the flight was a normal commercial flight and in no way engaged in training.

The pilots' statements state that they experienced difficulties in selecting the power levers to ground idle particularly getting them off the gates. The Captain's statement stated that the either one or both power levers were stuck.

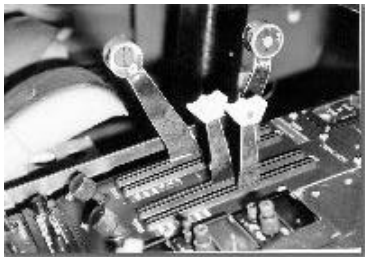


Fig 6. Positions of power, speed levers after salvage.

However, field inspection of wreckage, immediately following salvage demonstrated that both power levers could be got off the gates and the RHS had full and free movement. The reason for the left hand side power lever and speed lever jam was because the left hand power lever cable run and pulley assembly located at the left hand leading edge wing root was severely damage during the salvage of the aircraft, thus jamming the mechanism and preventing movement forward or aft.

The pulley attachment bracket had sustained a brittle failure, indicating instantaneous failure on impact/salvage operation. It was confirmed by the captain that the power levers could be moved forward and he did so to exercise same just prior to impact with the wall.



The airframe to engine power lever control linkage was disconnected at the engine power lever input. Direct function of the interconnected manual fuel valve and the propeller pitch control linkage was free and normal. After freeing the left hand engine control pulley assembly at the wing root the left hand power lever was free to function normally. This clearly indicate that



7. Failed control cable pulley bracket

prior to the impact/salvage operation, there could not have been a Figjamming of the power levers.

The condition of the propellers indicate that at impact with the sea, the LHS engine was developing power, whilst the RHS engines had stopped prior to contact with water. The CVR recording, from the master warning sound, did confirm that the RHS engine flamed out and the oil pressure warning which comes on below 40 psi (approximate RPM 55%) was just after the first impact.



Fig 8. Tyre Marks as aircraft left runway

The tyre marks show all four tyres firmly on the ground, with more weight on the LHS due to the skid to this side. Given the terrain, which was uneven at the sea-wall the indications are consistent with the statements of the pilots, that no attempt was made to get the aircraft airborne upon leaving the runway. Additional computer simulations carried out at Dornier factory; based on field data (in view of the structural damage) does also indicate that this to be the case.



Fig 9. Wheel marks on the unpaved surface.

The conditions of the engine, particularly inlets and compressor, show that the RHS engine failed due to ingestion of FOD. The red circular markings on the original inlet shows some piece of the NLG RHS wheel hub rim was thrown into the engine.

### 3. CONCLUSIONS

#### a) Findings

- i) The crew were properly licenced, medically fit and sufficiently rested to operate the flight.
- ii) The aircraft had been properly maintained correctly loaded and was airworthy at the time of accident.
- iii) During approach the Captain gave excessive guidance to the co-pilot.
- iv) The Captain although not content with the experience of the co-pilot, did not intervene when the co-pilot attempted to land at an angle of about 20° to the centreline of the runway and continued to allow the co-pilot to apply right rudder to correct the direction.
- v ) The engine developed power until the impact with the sea wall, at which point the RHS engine flamed out due FOD ingestion.
- vi) Power and RPM cable run and pulleys and the Christmas tree had no evidence of failure prior to accident, only an impact failure of pulley bracket on the LHS.
- vii) The height of the sea-wall caused the aircraft to somersault into the adjacent lagoon.
- viii) The aircraft skidded banking to the starboard due to centrifugal forces.



ix) Except for the pilots and one passenger all others egressed from the main door, opened by the Captain and cabin attendant.

x) All passengers had their seat belts on during landing.

b) Cause(s)

According to the investigation conducted and information obtained the following factors played a part in causing the accident.

a) the failure of the PIC to take control when the aircraft touched at 20° angle to the centreline and continued towards the western edge of the runway after landing

b) The "over correction" applied by the handling pilot to the prevalent cross wind, leading the aircraft to land at 20° to the centerline.

c) the over application of right rudder to get the aircraft onto centerline and subsequently failing to get the power levers to ground idle.

d) the lack of a CRM programme in the company had meant that the pilots albeit friendly, did not have a harmonious attitude towards one another; particularly the Captain to the Co-pilot.

e) the less than effective means of imparting company policy with respect to giving co-pilots (based on experience, flight conditions) to carry out landings/take-offs.

#### 4. SAFETY RECOMMENDATIONS

It is recommended that;

a) Crew Resource Management Training be introduced and incorporated in conjunction with comprehensive Line Oriented Flight Training. (LOFT)

b) Flying Staff Instruction, which are clear and precise be used and effectively disseminated so that all flying personnel are aware of company policy.

c) Company training procedures need to be reviewed, with a view to enhancing it.