No. 12

Polynesian Airlines Ltd., Douglas DC-3, 5W-FAB in the Apolima Strait, Western Samoa, on 11 May 1966. Aircraft Accident Report No. 25/4/18 dated 28 May 1966, released by the Department of Civil Aviation, New Zealand

1. - Investigation

1.1 History of the flight

The aircraft had carried out two scheduled domestic flights in the afternoon, one from Nandi, Fiji, to Faleolo and another from Faleolo to Pago Pago, American Samoa, and return. Both flights were uneventful and the aircraft landed back at Faleolo at 1717 hours Samoa time. While the aircraft was being unloaded the pilot-in-command decided to carry out the 180-day flight check of another pilot. The pilot-in-command, the pilot undergoing the flight check and the co-pilot of the previous flights, were heard discussing procedures for recovery from stalls and the pilot-in-command requested a company engineer to bring aboard the instrument flight hood for the aircraft and a newspaper, or a blanket, to cover the engine control pedestal (so that the pilot being checked could not observe the actions of the check pilot's hand). The three pilots boarded the aircraft; the pilot-in-command was seen to take the right-hand seat and the pilot being flight checked, the left-hand seat in the cockpit; the position of the co-pilot, who had been invited aboard at the last moment to "see for himself", was not observed. The air-stair door was closed from the outside by one of the airline's engineers assisted by an aircraft cleaner. They raised the door which closed normally and easily and moved the door-locking handle into the "closed" position, finally giving it a tug to ensure that the door was closed securely. They did not see any of the three occupants standing near the door, nor hear anyone check the door lock or fasten the safety chain.

The engines were started and at approximately 1735 hours the aircraft was taxied out to the runway threshold. After a normal run up of the engines the take-off roll was initiated. At one-third of the runway power on one engine was cut rapidly and the aircraft slowed violently but the swing was corrected and the aircraft brought to a stop. It was then taxied back to the take-off point, the engines were opened up to full power with the brakes applied and a short take-off carried out at approximately 1745 hours. When last seen from Faleolo the aircraft had reached an altitude of about 3 000 ft. At about 1810 hours, the aircraft was seen flying over the sea near the south-eastern tip of Savai'i and heading in the general direction of Upolu. Initially it was observed in open sky, disappeared briefly in or behind some grey cloud and came into view again at an altitude which was not determined. A number of persons in the vicinity of Salelologa, Savai'i, heard a marked increase in engine noise and when they looked upward they saw the aircraft which had been in straight and level flight, make a sudden turn to port and at the same time a loud bang, or double bang was heard. Almost immediately, an object resembling a large panel separated from the structure and flew rearward and upward. The turn developed into a straight and very steep dive from which the aircraft did not recover before it struck the sea. With pitch-down of the nose, the engine noise ceased entirely and was not heard again. Certain unidentified fragments fell behind the aircraft during its descent. A quantity of floating debris was later retrieved from the water but the main wreckage was not recovered. The accident occurred at 1810 hours (local time).

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	3		
Non-fatal			
None			

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

There was no other damage.

1.5 Crew information

The pilot-in-command, aged 41, was the chief pilot and general manager of the airline. He held a U.S. Commercial Airman's certificate, validated in New Zealand in December 1965, and a flight instructor rating which had been validated in April 1966. He had flown a total of 4 812 hours, including 1 060 hours on DC-3 aircraft, of which 388 hours were flown as pilot-in-command.

The pilot being flight checked, aged 29, held a U.S. Commercial Airman's certificate and also a New Zealand Air Line Transport Pilot's Licence with a type rating for DC-3 aircraft. As of September 1965 he had flown a total of 1 791 hours.

Also aboard was a supernumerary pilot, aged 27, who held a commercial pilot's licence. As of 30 April 1966 he had flown a total of 1 132 hours of which 352 hours were flown as co-pilot on DC-3 aircraft operated by Polynesian Airlines Ltd.

1.6 Aircraft information

A contract was awarded to a U.S. Certified Repair Station to modify and refurnish the aircraft to meet FAA and New Zealand civil aviation requirements. This included the fitting of an air-stair door on the left-hand side of the fuselage at the rear of the passenger compartment.

After being flown to Western Samoa, the aircraft underwent a customary official survey and was then issued with a New Zealand Certificate of Airworthiness valid from 25 August 1965 to 24 August 1966. The Maintenance Release of the aircraft was current at the time of the accident. As of 9 May 1966 the aircraft had flown a total of approximately 7 290 hours on Polynesian Airlines schedules.

1.7 Meteorological information

At 1600 hours on 11 May 1966 the following official weather observations were recorded at Faleolo Airport: wind, variable, 5 kt; visibility 20 NM; weather, cloudy 3/8 Cu-TCu at 5 000 ft, and 7/8 Ci-Cs at 25 000 ft; mean sea level pressure: 1 008.5 mb.

No abrupt weather changes occurred between 1600 and 1900 hours and neither Faleolo nor Apia reported thunder or lightning. At 1600 hours some cumulus cloud was present about the hills on the northern side of the island of Savai'i. The meteorological office at Apia reported that on 11 May 1966 the weather in the Western Samoa area was "little out of the ordinary".

1.8 Aids to navigation

Not pertinent to the accident.

1.9 Communications

The Flight Service Station providing radio communication between Faleolo and locally flying aircraft had not been advised beforehand of this training flight and had closed down at 1720 hours as normal. Neither Pago Pago nor Nandi received any messages from the aircraft.

1.10 Aerodrome and ground facilities

Not pertinent to this accident.

1.11 Flight recorders

Not mentioned in the report.

1.12 Wreckage

The accident occurred in the Apolima Strait, separating the principal islands of Savai'i and Upolu, Western Samoa. A Royal Australian Navy ship placed a reflector buoy in 180 feet of water at a point located some 500 yards offshore and in a general easterly direction from Tafua Crater on the southeastern tip of the island of Savai'i (13°46.7'S - 172°11.9'W) where it was believed that the greater part of the submerged wreckage probably lay. Divers from the Royal New Zealand Navy made an extensive search for the wreckage but, despite all their efforts, no trace of the main portion of the wreckage was found.

Floating debris was recovered from the sea and systematically laid out at Faleolo for detailed examination. Examination revealed that severe disruption of the fuselage from the cockpit to the main passenger door took place indicating very high impact forces and rapid deceleration at sea strike.

1.13 Fire

Since the Faleolo Airport fire crew were not advised that the aircraft would carry out another flight after its arrival from Pago Pago, they had gone off duty after its landing.

No evidence of fire or explosion was found on the debris which was recovered.

1.14 Survival aspects

There were no survivors.

1.15 Tests and research

No information was contained in the report.

1.16 The air-stair door on 5W-FAB

The air-stair door is not standard equipment on DC-3 aircraft. It was a component specially built and installed for rendering the aircraft independent of mobile steps for the convenient embarkation and disembarkation of passengers at places where no ground-based facility was provided. This air-stair door, a vertically mounted unit, was some 7 ft by 4 ft in dimensions, weighed between 180 and 200 lb and was piano-hinged to the fuselage along its lower edge. The door thus opened outward and downward to present a series of built-in steps extending close to ground level. It was held in its fully lowered position by two side chains, the forward being shorter than the aft on account of the position of its fuselage anchorage point. These chains also served as handholds for passengers using the steps. The door had to be raised and lowered manually and it was customary for ground crew personnel to raise it until it was flush with the fuselage and then for one person to turn the locking handle into the closed position.

The locking handle extended right through the door, thus enabling the door to be opened or closed both from within and without the aircraft. It operated three locking pins engaging in slots at the top of the door frame and at each side. The piano-hinge held the bottom of the door secure. With the handle placed in the open position, the pins were fully withdrawn from their slots; in the closed position the pins were engaged in the slots. Whenever the pins were withdrawn, a red light became illuminated on the right-hand side of the co-pilot's instrument panel.

It was considered that this warning light system was not wholly reliable. Engagement of the locking pin in its slot on the forward door-frame activated a microswitch which then turned the red light off. But it was learned that the locking pin did not require to be fully engaged before the switch turned off the light. Full travel of the locking pins needs to be discussed. Although a person outside the aircraft might place the locking handle in the closed position, it was still possible for a person inside to turn the handle a little further and thereby to force the pins further home. It was, in fact, established procedure after the ground crew had raised and closed the door and had placed the handle in the closed position, for the flight hostess to turn the inside handle a little further - i.e. as far as it would go - and then to place a short length of chain in position so that, should the locking pins fail or accidentally become withdrawn, it would prevent the air-stair door from opening outward more than a few inches. If the safety chain were not used, the door would be free to fall into its fully lowered position and if this happened in flight the weight of the door would probably result in its being torn away from the fuselage. A more acceptable system would appear to be one in which the red warning light would not go out until the locking pins were engaged to the full extent of their travel and, most importantly, unless the safety chain were correctly fastened in place.

2. - Analysis and Conclusions

2.1 Analysis

An analysis of the Trip Records of this aircraft over the previous six months revealed that the air-stair door had been the subject of ten defect reports. The most significant were two cases in which the door had fallen fully open while the aircraft was

on the ground and which had resulted in detachment of the lower end chain fittings, and four cases in which the door warning light came on in flight even though, on close inspection, the door appeared to be securely closed. Adjustment of the microswitch rectified the defect in these latter cases.

It was learned that on another occasion the door had fallen open when the aircraft was on the ground but the safety chain prevented it from opening more than a few inches. It was also learned that on an unspecified number of occasions attempts had been made to close the door from the outside while the door handle was in the closed position resulting in distortion of the locking pins. As these defects occurred, they were properly rectified. However, they indicated that the air-stair door was chronically giving trouble and could not be considered safe in flight unless the safety chains were firmly in place.

Before the aircraft departed Nandi on a previous flight on the day of the accident difficulty was experienced in closing the door which had had to be levered within its frame to allow the locking pins to engage properly. In view of the shortcomings present in the door warning light system, only a close personal check by somebody within the aircraft could have established with certainty that the door locking handle was in the fully closed position and the safety chain correctly engaged. Since none of the three occupants had been seen near the doorway when the door was closed from the outside it was considered likely that the locking pins were not fully engaged and the safety chain not in use at take-off. There was, however, no evidence to confirm this view and only recovery of the main wreckage from the sea bed might have allowed the situation to be determined without doubt.

From the analysis of the accounts of the witnesses and from the examination of the debris it was concluded that:

(a) an increase of engine power took place

(b) the aircraft yawed or turned to the left in a moderate nose-up attitude

(c) a comparatively large component separated from the aircraft's structure, followed by a loud bang or double bang

(d) there was a sudden pitchdown of the nose of the aircraft

(e) the aircraft dived very steeply and steadily without turning or rotating during its descent until it struck the sea

(f) neither a fire nor an explosion occurred in flight

(g) the mainplanes did not separate from the fuselage in flight.

In view of the above it was concluded that the accident resulted from the following chain of events:

(1) While the aircraft was flying straight and level in normal cruising flight, the air-stair door, unsecured by its safety chain, fell outward and downward to the full extent of its travel;

(2) Air resistance offered by the door caused the aircraft to yaw to port and to counteract this the pilot, among other actions likely to have been taken, increased power on the port engine. This resulted in an increase of engine noise and a change of noise consistent with engines being out of synchronization; the noise attracted the attention of persons on the ground;

(3) The sudden dropping of the heavy door resulted in fracture of the forward handhold chain and the disruption of the piano-hinge at the door bottom, thereby allowing the door to thrash about on the end of the aft handhold chain;

(4) The door struck the port tailplane and/or elevator a massive upward blow and severely damaged that or those components;

(5) The aft handhold chain parted and the door was hurled upward and rearward, clear of the structure;

(6) The tailplane and/or elevator was so damaged or displaced as to present an increased angle of attack to the relative airflow and this resulted in pitch-down of the nose and irretrievable loss of fore and aft control;

(7) Since no damage occurred to the mainplane structure or to the vertical tail surfaces, the aircraft dived in a laterally and directionally stable attitude, only pitch control remaining ineffective;

(8) The aircraft struck the sea and disintegrated.

The bang or double bang heard by some witnesses is likely to have been the sound made by collision of the door with the aircraft's tail, while the panel-like object seen to become detached and to fly rearward and upward may equally well have been the door itself.

It was considered highly improbable that a structural failure might have occurred as a consequence of air loads imposed during normal flight under the weather conditons prevailing at the time. Neither was there any evidence to suggest that the aircraft had been subjected to a flight manoeuvre which might have imposed upon the structure some loading beyond its designed capacity. If, as reflected by the discussion between the pilots before boarding the aircraft, the flight included stalls and recoveries, and single-engine flying, the structure would have been subjected to minor vibrations and warping capable of causing movement of the door locking pins. In this connexion it was mentioned that the air-stair door fell open on one occasion while one engine was being run up on the ground and that this was attributed to vibrations set up in the structure.

2.2 Conclusions

(a) Findings

The pilots involved in the accident held valid licences and type ratings for Douglas DC-3 aircraft.

The aircraft was covered by a valid Certificate of Airworthiness and Maintenance Release.

The air-stair door is unlikely to have been secured by its safety chain while the aircraft was in flight.

While the aircraft was in flight a component believed to have been the air-stair door fell open and was carried away in the slipstream.

Collision between the object that was carried away and the aircraft's tail resulted in displacement of or damage to the port tailplane and/or elevator which produced irretrievable loss of fore and aft control.

A pitch-down of the nose resulted and the aircraft dived steeply out of control into the sea.

Neither smouldering, fire, nor explosion occurred aboard the aircraft while it was in flight.

(b) Cause or
Probable cause(s)

The probable cause of the accident was the in-flight opening and separation from the structure of the air-stair door which struck the aircraft's tail and so damaged it that uncontrollable pitch-down of the nose resulted in the aircraft diving into the sea.

3. - Recommendations

The following comment was made in the report:

A lesson to be learned from this investigation is that the air-stair door, or any other form of door which does not tend to be held closed by in-flight pressure of the relative airflow, ought to incorporate an effective geometric lock in the closing mechanism and a red warning light in the cockpit which should extinguish itself only when the locking device (in the present case the safety chain) is properly safetied.

Training
En route
Airframe - Air
Airframe - door

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