

No. 17

Air Ferry Ltd., DC-4, G-ASOG, accident at Frankfurt, Federal Republic of Germany, on 21 January 1967. Report No. 812.1-1/67, dated 5 February 1968, released by the Federal Office of Civil Aeronautics, Federal Republic of Germany. Also published by the Board of Trade, United Kingdom, as C.A.P. 310

1.- Investigation1.1 History of the flight

Flight BE/LH 200 was a non-scheduled international cargo flight from Manchester to Frankfurt. An IFR flight plan via Congleton beacon, airways Amber 1, Amber 2, Blue 3, Dover beacon and airway Green 1 to Frankfurt was filed. Take-off from Manchester was scheduled at 0010 hours GMT; however, because of a malfunction in the door warning device, the flight took off at 0119 hours. At 0402 hours it contacted Frankfurt Approach Control. It was requested to report over Frankfurt VOR and was given a QNH of 1018 mb. At 0405 hours the flight reported over Frankfurt VOR at FL 60 and was instructed to carry out an ILS approach to runway 25R. At approximately 0410 hours the flight was advised that it was 8 miles from touchdown and instructed to contact the tower on 118.7 MHz and to continue its ILS approach to runway 25R. The flight immediately contacted the tower and was cleared to land on runway 25R, the wind being calm. This was acknowledged by the flight: at no time was the QFE given to or requested by the flight.

Two minutes after its last radio transmission and whilst on a heading of about 260°, the aircraft struck a tree approximately 2 700 m before the threshold of runway 25R and 100 m left of the extended centre line. After striking several more trees it continued on a track of about 280° and crashed. The accident occurred at approximately 0413 hours.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	2		
Non-fatal			
None			

1.3 Damage to aircraft

The aircraft was destroyed by impact and the ensuing fire.

1.4 Other damage

Moderate ground damage was caused at the accident site.

### 1.5 Crew information

The pilot-in-command, aged 46, held an airline transport pilot's licence valid until 14 October 1970. His last medical examination took place on 4 October 1966. He passed his last instrument rating on 9 November 1966 and his last proficiency check as pilot-in-command of DC-4 aircraft on 6 January 1967.

He had flown a total of approximately 6 600 hours including approximately 1 000 hours as pilot-in-command in DC-4 aircraft and approximately 600 hours in DC-7C aircraft. His night flying experience amounted to approximately 600 hours. There is no record that he had landed at Frankfurt before.

He had not exceeded the maximum permissible flying time during the last 28 days nor the maximum duty time during the last flight and he had proper rest time prior to the flight.

Post-mortem examination did not reveal any intoxication due to carbon monoxide or to alcohol and his death was attributed to the injuries sustained. According to the medical evidence, at the moment of impact he was in his seat in the cockpit but the injuries to his hands indicated that he was probably not holding the control wheel.

The co-pilot, aged 25, held a commercial pilot's licence valid until 8 October 1969. His last medical examination took place on 4 October 1966. He passed his last instrument rating on 9 June 1966 and his last proficiency check as co-pilot in DC-4 aircraft on 3 November 1966.

With regard to the maximum permissible flying hours and flight duty hours and minimum rest periods the same conclusions were reached as for the pilot-in-command.

Post-mortem examination did not reveal any intoxication due to carbon monoxide or alcohol and his death was attributed to the injuries sustained. According to the medical evidence, at the moment of impact he was in his seat and probably holding the control wheel.

### 1.6 Aircraft information

The certificate of airworthiness of the aircraft was valid until 5 April 1967. The last certificate of maintenance had been issued on 14 January 1967 with a period of validity of up to 35 701 flying hours or until 18 February 1967.

All airworthiness directives had been complied with. All technical defects recorded in the technical log book to 20 January 1967 had been duly noted as remedied.

Before take-off from Manchester the aircraft was refuelled with 1 670 US gallons of fuel which gave an endurance of approximately 6 hours.

The type of fuel being used was not stated in the report.

Its estimated take-off weight was 30 903 kg and its estimated landing weight 29 006 kg (including 7 067 kg of freight). The approved maximum take-off weight was 33 470 kg, and the approved maximum landing weight was 29 100 kg. The centre of gravity for take-off and landing was approximately 20 per cent MAC, i.e. within the approved limits of 16 per cent to 32 per cent MAC.

### 1.7 Meteorological information

The crew were properly briefed by the Meteorological Office at Manchester before their departure.

The weather forecast for Frankfurt valid from 2200 to 0700 hours was as follows: wind 180°/05 kt; visibility 2 000 m, rain; cloud 6/8 at 400 ft, 7/8 at 2 000 ft.

The last two weather reports broadcast before the accident were:

From 0333.40 hours: Weather at Frankfurt at 0320 hours: wind calm; visibility 2 500 m; cloud 2/8 at 1 000 ft, 8/8 at 2 200 ft; temperature 2°; dew point 1°C; QNH 1019 mb; no significant change expected.

From 0411:40 hours: Weather in Frankfurt at 0350 hours: wind variable/01 kt; visibility 3 km; cloud 8/8 at 2 000 ft, temperature 2°; dew point: 1°C; QNH 1018 mb (30.06 inches); no significant change expected.

According to another pilot, who carried out an ILS approach approximately 3 minutes after the subject aircraft, there was a slant visibility of approximately 5 NM and cloud layers with base 300 to 400 ft and tops 600 to 800 ft in the approach sector; approach lights were intermittently visible from over the accident site at ILS glide path height, but not the runway lights.

### 1.8 Aids to navigation

The ILS installation on runway 25R was operating at the time of approach. Two special flight calibrations carried out after the accident showed that the course line and approach angle indicated by the localizer and the glide path were within tolerances. This was confirmed by a pilot who carried out an ILS approach about 3 minutes later and by three other pilots who landed approximately 40 minutes before and 1 to 2 hours after the accident. An enquiry regarding possible fluctuations in the ILS glide path indications for the runway concerned was made. Some pilots reported that they had noticed fluctuations up to five days before or more than three days after the accident. Some of these fluctuations were within the limits for cutting off radiation by the monitor laid down at the time of the accident by ICAO Annex 10 chapter 3.1.4.6.3. It was not possible to discover in detail whether installations aboard the aircraft were defective, or by what means deviation from the ILS glide path could be brought about outside the area controlled by the monitor.

As a further aid to navigation a surveillance radar was serviceable. It was used solely for traffic guidance and for indicating the track to intercept the ILS localizer. The precision approach radar was not operating. This fact had been promulgated by NOTAM of AIS Manchester on 20 January 1967.

### 1.9 Communications

Communications were normal until 0411 hours when the last communication from the aircraft was received. At no time did the crew report any difficulties.

### 1.10 Aerodrome and ground facilities

#### Approach lighting

Sequenced flashing lights were not operating at the time of the accident.

White variable high intensity uni-directional lights were operating at Level 4 (30%) and white low intensity omni-directional lights were operating normally.

#### Threshold lighting

Two flashing lights (coupled with sequenced flashers) were not operating.

Green variable high intensity uni-directional lights (coupled with runway high intensity uni-directional lights) were operating at Level 4 (30 per cent).

Green low intensity omni-directional lights (coupled with runway low intensity omni-directional lights) were operating.

#### Runway lighting

White variable high intensity uni-directional lights were operating at Level 4 (30 per cent) and white low intensity omni-directional lights were operating normally.

The VASIS was not operating. This fact had been promulgated in NOTAM of AIS Manchester of 20 January 1967.

### 1.11 Flight recorder

The aircraft was not equipped with a flight recorder.

### 1.12 Wreckage

The first impact marks were found on an oak tree about 160 m from the main wreckage and about 10 m above the ground. Part of the starboard wing tip was found in the immediate vicinity of that tree. Both wings were subsequently torn into many fragments by contact with numerous other trees.

Detailed examination of the wreckage indicated that at the time of impact the undercarriage was fully extended and locked, the flaps symmetrically extended to about 30° and all four engines operating and probably developing more than 600 bhp each. No evidence of a structural failure of the aircraft or its systems prior to impact was found.

The pilot-in-command's first altimeter (used for take-off and landing) was set at 1018.5 mb, the other at 29.92 in. Hg and the co-pilot's altimeter at 30.08 in. Hg. Evidence revealed that at the time of impact AC/DC current was available and that all gyro and vacuum operated instruments were running.

### 1.13 Fire

Evidence revealed that about 20 m after the first impact with the oak tree, both wings started to disintegrate and the integral tanks to rupture. As a result approximately 1 000 US gal of fuel escaped and caught fire and the main wreckage as well as a ground area of 200 sq. m. were subject to an intense fire for a considerable time.

#### 1.14 Survival aspects

Both occupants had sustained fatal injuries on impact.

#### 1.15 Tests and research

No tests were carried out.

#### 1.16 Other information

The operator's operations manual contains the following instructions:

##### 1.16.1 Altimeter setting procedure

- (a) Before take-off all altimeters are to be checked for correct reading. The maximum tolerance is  $\pm 60$  feet on QFE setting.
- (b) In the descent through the transition level the pilot-in-command's altimeter is to be set to QFE, the co-pilot's altimeter to QNH, and a check is to be made that the difference between the two readings corresponds to the airfield elevation.
- (c) After clearance for landing the co-pilot's altimeter is also to be set to QFE.

##### 1.16.2 Approach check list

- (a) The approach check list contains the direction that both altimeters of the pilot-in-command and the co-pilot are to be set to local values, one altimeter to QFE and the other to QNH.
- (b) The final approach check list contains no directions for the setting of the altimeters.

##### 1.16.3 Approach procedure

An ILS approach on 4 engines is normally made with undercarriage lowered, landing flaps at  $30^\circ$ , indicated air speed 125 kt rpm 2 250 or 2 500 and boost pressure 28 to 30 or 23 to 25 inches.

##### 1.16.4 Operator's weather minima at Frankfurt Airport

The operator's weather minima for landings at Frankfurt Airport were as follows:

ILS approach to runways 25 L and R: runway visibility 600 m, critical height 200 ft

NDB approach to runways 25 L and R: runway visibility 800 m, critical height 450 ft

According to the AIP the obstacle clearance limits were 190 ft for ILS approaches and 420 ft for NDB approaches to runway 25 R.

## 2.- Analysis and Conclusions

### 2.1 Analysis

The flight apparently progressed normally until the last communication of the aircraft approximately 5-6 NM before the threshold of runway 25 R. The aircraft then descended below the glide path and collided with trees, about 10 m above the ground approximately 2 700 m before the threshold. The prescribed weather minima with regard to runway visual range and cloud ceiling were not infringed, notwithstanding the isolated patches of stratus cloud probably present in the approach sector. There was no turbulence, icing or extreme wind shear. The efficiency of the controls and the performance of the engines were clearly not impaired by meteorological factors, although probably carburettor warm air had been selected by the crew to guard against carburettor icing.

The weather on the approach made no special demands on the ability and operational efficiency of the crew; according to the evidence of another pilot who landed shortly thereafter, a visual approach was possible 5 NM before the threshold of the runway. Isolated patches of low stratus cloud may have made it necessary to continue the approach by instruments for a short time at low altitude, but this should not have caused the aircraft to descend below the critical height. The aircraft was in proper approach configuration and no evidence of malfunction or failure of the aircraft, its engines or its systems which could have caused this premature descent was found. The possibility that the ILS, especially the glide path installation, may have been defective was examined. Fluctuations in the ILS glide path had been reported but on days other than that of the accident. The pilot who landed immediately after the accident and three others who landed 40 minutes before and 1-2 hours after the accident did not have any difficulties and two calibration flights carried out after the accident showed that the ILS was working within the permissible tolerances.

Nevertheless, a brief fluctuation of the glide path system within the permissible tolerances at the time of the accident cannot be excluded with certainty. Such a brief fluctuation would produce a change in the indicator reading which would be disquieting for the pilot but would demand such an abnormally abrupt change of flight path that it is unlikely it would be acted upon. Furthermore, the aircraft should not have descended below the critical height, since the crew is required by the Regulations not to descend below this value in any circumstances without visual reference.

The approach lighting, the obstacle and runway lighting were operating normally and at the proper intensity. The absence of VASIS could have added to the pilots' difficulties; however, the crew had already been informed by NOTAM that the VASIS was not operating.

Premature descent below critical height was certainly unintentional, therefore it is necessary to consider in detail what faults may have led to this.

From examination of the lashing and securing equipment and the setting of the elevator trim it appears that the cargo was properly lashed and did not become displaced in flight.

The landing lights were not extended and therefore not switched on. However, there is no regulation regarding the time at which landing lights should be switched on and the decision is left to the pilot having regard to the relevant weather situation. Although the accident might possibly have been prevented if the landing lights had been on, there is no reason why the crew should have used these lights at this stage of the approach.

Whether and how far the ILS system was used by the crew for the approach could not be ascertained. Weather conditions were such that an ADF approach was permissible. Possibly the good weather conditions which were reported and at first encountered caused the crew to begin a visual approach at a substantial distance (5 NM). The low patches of stratus cloud in the vicinity of the airport had not been mentioned in the weather report, since the cloud searchlight was installed approximately 1 200 m before the threshold of the runway. If the crew did not see these patches of cloud during the long final approach, they were possibly surprised by their presence and decided to fly below them. It is certain, however, that a considerable time before the impact the crew was able to fly visually and to see the approach and runway lighting. It therefore seems probable that the crew was already concentrating on the impending landing and using the altimeters only as aids to checking the flight path. Normally both of these pilots used to set their altimeters to the QFE for the final approach and landing, in accordance with the instructions contained in the Operator's Operations Manual (see 1.16). However, the pilot-in-command's first altimeter and the co-pilot's altimeter were both found set to the QNH. Furthermore the tape recording of the radio communicator revealed that the crew did not request the QFE from ATC. This should have been done approximately 8 minutes before the accident as the aircraft passed through the transition flight level, and at the latest approximately 3 minutes before the accident after having been given landing clearance. Why the crew did not comply with the operator's instruction (see 1.16.1 (b)) in spite of a similar direction in the check list cannot be explained. The fact that the co-pilot's altimeter was not set at the QFE (see 1.16.1 (c)) may be explained by the fact that this was not stated in the final approach check list, which, however, did require the pilot-in-command's altimeter to be set to QFE.

It is considered that these errors were of decisive importance in the accident. Their inevitable consequence was that before reaching the approach lighting the crew was flying 368 ft or even 428 ft (taking into consideration a possible altimeter error of 60 ft) lower than they assumed from the height shown, for their altimeters were set to QNH, whereas they could have believed they were set to QFE. Consequently, the pilot-in-command would have been under the impression, assuming he looked at his altimeter at this stage, that he still had approximately 200 ft to descend to critical height when the accident occurred.

A purely instinctive estimation of the height and thus of the safe glide path without the use of altimeter readings or approach path guidance is not possible at night.

According to the history of the flight and the post-mortem examination, the possibility of a physical incapacitation of both pilots seems improbable. The medical report of the hands of the co-pilot may be explained by the fact that he was probably flying the aircraft at the time of impact.

## 2.2 Conclusions

### (a) Findings

The crew were properly certificated and qualified for the flight. However, there was no record that the pilot-in-command had ever landed at Frankfurt before.

The aircraft had a valid certificate of airworthiness and had been properly maintained. Its gross weight and centre of gravity at take-off and at the time of the accident were within the permissible limits.



The flight progressed normally until the last communication of the aircraft approximately 5-6 NM before the threshold of runway 25R. The aircraft then descended below the glide path and collided with trees approximately 2 700 m before the threshold.

Weather conditions at the airport were above the prescribed weather minima.

The radio navigational aids, and the approach and runway lighting were operating normally: the strength of the lighting used was adequate for the visibility conditions. The VASIS was inoperative and the crew had been duly notified by NOTAM. The approach sequenced flashing lights were not in use.

No evidence of a malfunction or failure of the aircraft, its engines, or its systems prior to impact was found. The pilot-in-command's altimeters were found one at a setting of 1018.5 mb corresponding to the QNH, the other at 29.92 in. Hg, and the co-pilot's altimeter at a setting of 30.08 in. Hg corresponding also to the QNH. In accordance with the operator's instructions and with normal crew practice, both the pilot-in-command's first altimeter and the co-pilot's altimeter should have been set at the QFE.

(b) Cause or  
Probable cause(s)

The accident is probably attributable to the fact that the crew did not set the altimeters in the final approach according to the instructions in the operations manual. This error was aggravated by the fact that the final approach check list did not coincide with the altimeter setting procedure. In consequence the crew unintentionally flew below critical height and the aircraft collided with trees when the altimeters were showing approximately 200 ft above the critical height.

3.- Recommendations

An alteration to the check list of the operations manual recommended as an immediate measure was undertaken on 23 February 1967. However this accident, together with parallel cases, should provide the occasion to subject the validity of the procedure for the setting of altimeters prescribed by ICAO Doc 4444-RAC/501/9 to re-examination. For flights under instrument flight rules QFE should always be used instead of QNH for take-off and landing below transition altitude or transition flight level (QNH only on request or in cases in which the QFE scale is inadequate). In this way misinterpretation of the altimeter, especially on instrument approach or circuit approaches, would be prevented, since at every airport the pilot reads off the relevant height above the airfield without conversion, quite apart from the psychological factors produced by the fact that the altimeter always presents the same appearance on take-off and landing. By this measure similar accidents could be prevented in future. There should be no special difficulties for traffic direction after a corresponding adaptation of the procedures for the air navigation service.