

LANDING PHASE

No. 8

United Arab Airlines, DH-106 - Comet 4C, SU-ALC, accident at Tripoli International Airport, Libyan Arab Republic, on 2 January 1971. Report, dated 1 November 1971, released by the Civil Aviation and Meteorological Administration, Libyan Arab Republic

1.- Investigation

1.1 History of the flight

Flight MS 844 was a scheduled international flight from Algiers to Cairo with an intermediate stop at Tripoli. Departure on the outbound flight Cairo - Tripoli - Algiers had been delayed 29 hours due to adverse weather conditions along the route. At Algiers, following testing of the system, the fire warning light of Zone 1 in No. 3 engine stayed "ON". Local personnel, who were not familiar with Comet aircraft, attempted to rectify the discrepancy and this caused a further delay of nearly 2½ hours. The light eventually extinguished and the pilot-in-command, who had been considering cancellation of the flight and returning to Cairo without passengers, then decided to proceed with the service.

There was no evidence that the crew had asked for, or received, a weather forecast before departing Algiers for Tripoli; however, it is possible that a verbal forecast was obtained. The QNH at Algiers was 1 011 mb.

As the aircraft entered the Tripoli Control Area, the crew was provided with a weather report which included a horizontal visibility of 1 000 m due to sand haze. This was below the minimum authorized by the airline; however, the vertical visibility was unlimited.

The pilot-in-command checked Benina weather and then decided to attempt a landing at Tripoli with Malta as the alternative: he stated that he had 3 hours 50 minutes endurance. Both Tripoli Control and Tripoli Tower gave him a QNH of 1 008 mb, additionally Tripoli Control gave an opinion that visibility was better than 1 000 m, and Tripoli Tower gave an opinion that he could see "3 kilometres".

The airport's VOR was not available as it required calibration; the only ground aid available was the ADF facility. Coming from Algiers, the approach over the beacon located 0.6 NM north of Runway 18, the runway in use, involved joining the holding pattern in the opposite direction to the circuit so that a tear drop turn was necessary to re-approach the beacon on the outbound leg on an ADF procedure turn. Shortly after passing the beacon for the first time, the pilot-in-command reported at 3 000 ft. The last message received was when the aircraft was passing the beacon outbound for an ADF approach procedure turn. The altitude was not stated subsequent to entering the holding pattern.

The flight path to Runway 18 crossed an expanse of sand dunes 160 ft AMSL rising steeply to 425 ft AMSL and then falling to the runway threshold elevation of 240 ft. The aircraft struck sand dunes at an elevation of 395 ft approximately 7 km before the threshold of the runway. The accident occurred at 01.25 hours GMT.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	8	8	
Non-fatal			
None			

1.3 Damage to aircraft

The aircraft was destroyed by the impact and subsequent fire.

1.4 Other damage

There was no other damage.

1.5 Crew information

The pilot-in-command, aged 38, held a valid airline transport pilot's licence. He had completed a route check on 5 August 1969 and a proficiency check on a simulator on 6 December 1970. His previous experience on the route Cairo - Tripoli was in July 1970 as a check pilot, and in August 1970 as pilot-in-command. He had flown a total of 6 692 hours including 3 554 hours as pilot-in-command of which 1 382 hours were flown on Comet aircraft. He had flown 70 hours during the last 90 days, 15 hours during the last 28 days all of which were flown during the 7 days prior to the accident. He possessed a current medical certificate.

The co-pilot, aged 40, held a valid airline transport pilot's licence with a rating in Group II on Comet aircraft since 3 June 1968. He had completed a proficiency check on a simulator on 25 August 1970. He had been involved in a United Arab Airlines Comet accident at Munich, Federal Republic of Germany, in February 1970. He had flown a total of 3 793 hours including 1 550 hours as pilot-in-command and 2 243 hours as co-pilot on Comet aircraft. He had flown 249 hours during the last 90 days, 93 hours during the last 28 days and 30 hours during the 7 days prior to the accident. He possessed a current medical certificate.

A supernumerary pilot, aged 25, was also aboard the aircraft. He held a valid commercial pilot's licence. He had flown a total of 303 hours including 153 hours as third pilot in Comet aircraft, all of which were flown during the last 3 months prior to the accident. He possessed a current medical certificate.

The flight engineer, aged 30, held a valid flight engineer's licence endorsed for DC-6B and Comet 4C aircraft, the latter type having been added on 19 August 1970. He had flown a total of 3 480 hours including 330 hours on Comet 4 aircraft of which 188 hours were flown during the last 90 days, 72 hours during the last 28 days and 14 hours during the 7 days prior to the accident. He possessed a current medical certificate.

When leaving Algiers the crew had already been on duty for 10½ hours.

1.6 Aircraft information

The Certificate of Airworthiness of the aircraft was valid until 2 June 1971. A certificate of maintenance had been issued on 26 November 1970 and was valid for 45 days or 250 hours; however, it had been extended twice with the approval of the Chief Inspector of the airline: the first time to 275 hours and the second time to 280 hours. The aircraft had flown 271 hours since the last Check I No. 5. It had flown a total of 25 592 hours including 1 534 hours since the last Check IV. Prior to the accident no malfunctioning of the aircraft or its systems was reported.

The gross weight of the aircraft at the time of the accident was 52 845 kg, below the maximum of 73 500 kg authorized by the Certificate of Airworthiness. The centre of gravity at the time of the accident was computed to be 16.7 per cent within the allowable limits of 15 per cent - 20 per cent.

1.7 Meteorological information

Meteorological information at Tripoli International Airport was: 0120 hours GMT: Wind 130°/6 kt, visibility 1 500 m, dust haze, clear sky, QNH 1008 mb, QFE 998.5 mb. 0125 hours GMT: Wind 130°/4 kt.

Note: Runway Visual Range (RVR) measurements are not available at Tripoli International Airport.

Meteorological information at Benina International Airport was: 0030 hours GMT: Wind 120°/16 kt, visibility 2 000 m decreasing occasionally to 1 000 m, dust haze, clear sky, QNH 1015.2 mb.

The crew did not obtain a weather briefing by the Algerian Meteorological Office before departure from Algiers.

Two meteorological warnings had been issued for Tripoli on 1 January, the first one at 2034 hours, valid from 2035 hours to 2400 hours. the second one at 2358 hours, valid from 0001 hours to 0300 hours on 2 January. Malta confirmed that the two warnings were received and passed to the flight at 0101 hours on 2 January as well as Benina warning No. 2. The report did not mention the information contained in those three warnings.

The night was dark (moonless).

1.8 Aids to navigation

The Tripoli VOR was not available to the flight, as it required calibration. The only aid available to the flight for its approach to Tripoli was the "TPI" NDB on 352 kHz which was operating satisfactorily at the time of the accident. No report of abnormal operation was received from the crew of the aircraft. Runway 18 was equipped with a VASI system which was also operating. The aircraft was equipped with sufficient radio navigation equipment for the flight. A radio altimeter was not installed in the aircraft.

1.9 Communications

The aircraft carried three VHF communication sets. Communications between the flight and Tripoli ATC were conducted normally on 118.1 MHz and 118.5 MHz until approximately 0122 hours GMT when the aircraft reported over the NDB outbound. This was the last message received from the aircraft.

The normal procedure would have been to report when completing the procedure turn (inboard) some 40-50 seconds before impact. This was not received.

1.10 Aerodrome and ground facilities

There was no visual aid for location of the airport. Runway 18 was provided with red variable intensity approach centre line lighting, with crossbar, green variable intensity threshold lighting, and white variable intensity runway lighting. Obstruction marking and lighting was also available.

A certificate was issued by the Director of Technical Services at the Airport, certifying that all ground installations were operating normally at the time of the accident.

1.11 Flight recorders

The aircraft was not equipped with a flight recorder.

1.12 Wreckage

The accident occurred in rough terrain consisting of 10 to 20 ft high sand dunes, the mean level of the terrain being at an elevation of 395 ft. The aircraft first struck the ground with the right undercarriage, then the two pod tanks which contained a total of approximately 1 ton of fuel struck two sand dunes about 10 ft high and the fuel ignited instantly.

The aircraft struck the ground with a slight bank of about 5 degrees to the right with such a force that the left undercarriage strut and the nose undercarriage were detached immediately and the aircraft began to disintegrate starting with the right aileron, then the right wing tip, then the remainder of the right wing, and finally the left wing. The left wing exploded, and its upper surface flew upwards and came to rest at the right side of the wreckage. The centre part of the left wing between rib No. 3 to rib No. 12 (the part which contains tanks Nos. 2, 3 and 4) came to rest at about 70 m from the main wreckage, exploded and caught fire.

The right tail plane and elevator became detached as well as the right wing centre section, then the aircraft struck another sand dune about 20 ft in height, and the fuselage rotated 30° to the right of its forward path. It came to rest in that position with the port wing centre section still attached. It was completely destroyed by fire as far as frame No. 56.

The engines were detached together with their mountings and the front main spars of the two wings, indicating that the aircraft struck the ground with a high forward speed. Engine No. 1 came to rest about 20 m to the left of the main wreckage, together with the two port jet pipes. Engine No. 2 came to rest underneath the port tail unit. Engine No. 3 came to rest about 40 m in front of the main wreckage and slightly to the right hand side of it. Engine No. 4 came to rest about 70 m in front of the main wreckage along the main direction.

The wreckage trail was generally oriented on a heading of 176 degrees and the main part of the wreckage was located approximately 3.18 NM north of the "TPN" NDB, i.e. 3.78 NM north of the threshold of Runway 18.

No evidence of structural malfunction or failure of the aircraft, its engines or systems was found. There was no evidence of pre-impact fire, lightning strike or bird impact. The condition of the engines was discussed with Rolls Royce and it was considered that the fact that the engines ingested a large amount of fine sand at the beginning of the crash would have caused a rapid deceleration of RPM which explained why no evidence of high RPM was found when ingestion of solid matter occurred. It was determined that at the time of impact the undercarriage was extended and locked, the flaps at a setting of 40 degrees and the "Air Brakes" fully retracted.

1.13 Medical and pathological information

Examination of crew members' medical records did not indicate any health deficiencies or circumstances which may have had any bearing on the accident.

Examination of bodies did not reveal any injuries which may have been caused by fire arms or explosives.

1.14 Fire

A fire occurred immediately after the two fuel pods struck the sand dunes and a second fire occurred when the left wing disintegrated. Most of the main part of the wreckage was extensively destroyed by fire.

The fire and rescue services reached the site approximately 9 minutes after the occurrence of the crash, and acted very efficiently.

1.15 Survival aspects

This was a non-survivable accident.

1.16 Tests and research

Three altimeters were recovered and sent to Smiths' Factories for examination and testing. One was identified as the navigator's altimeter, but it was not possible to determine the serial numbers or installed position of the other two.

(i) The report concerning the navigator's altimeter stated that, because of the damage incurred and the resultant de-meshing of the capsule pointer gear train, it was impossible to establish the altitude indication at impact; however, the millibar setting of 1011.5 mb could not have been influenced by rotation of the setting knob after removal from the wreckage. It was considered possible that shock on impact may have caused counter rotation but no direct evidence was found that this occurred. There was no evidence to suggest that the altimeter was unserviceable prior to the accident and all discrepancies noted were consistent with impact damage.

(ii) The report concerning one of the unidentified altimeters stated that because of the fire damage and the de-meshing of the capsule to pointer gear train, it was impossible to establish the actual altitude indication at impact. However, the cam to cam follower relationship was such as to have required a millibar setting of 1046 mb in a serviceable altimeter. This would have resulted in a pointer display of 1 000 ft in excess of the actual pressure altitude.

The possibility that the cam/cam follower relationship may have been altered during the impact was considered. To change the correct setting of 1008 mb to that equivalent to 1046 mb would have entailed some 425 degrees rotation of the main altimeter mechanism and $7\frac{1}{2}$ revolutions of the counter setting knob. There was no evidence to suggest whether or not this had occurred. Additionally, it is possible that the cam/cam follower relationship may have been maladjusted during faulty servicing but no evidence was discovered to confirm or refute the possibility.

(iii) The report concerning the other unidentified altimeter stated that due to the severe damage incurred, it was not possible to obtain any information of any altitude indication at impact. The cam follower position suggested a setting of 1000 mb; however, the possibility of movement of the cam follower during the impact was not over-ruled. The difference between 1000 mb and 1008 mb represented a movement of the cam follower in the slot of approximately one tenth of an inch.

Two vertical gyros of the attitude indicators were also recovered and sent to Ferranti Ltd. for testing. The report stated that the extensive damage sustained prevented any assessment of aircraft attitude at impact. No evidence was found to suggest that the vertical gyros were not operating normally prior to impact.

1.17 Landing minima and procedure

By night, for an ADF approach to Runway 18 United Arab Airlines required a visibility of 3 200 m and imposed a minimum descent altitude of 600 ft above the airport elevation of 263 ft, i.e. 863 ft.

United Arab Airline procedures required that, for descent, the QNH be set on all altimeters. The Board of Investigation noted that the crew did not request the QFE setting.

2.- Analysis and Conclusions

2.1 Analysis

The evidence indicated that the pilot-in-command initiated an instrument approach when the official weather observation, the contents of which he had been advised, reported the visibility as being below the minimum authorized by the airline. The evidence also indicated that the aircraft was operating normally but was flying 1 000 ft below the altitude at which it should have been. The probable reason for the descent below the intended altitude was the incorrect setting of the QNH on one of the pilots' altimeters; that is, an altimeter was set 38 mb too high and this would have indicated that the aircraft was flying 1 000 ft higher than its actual altitude.

The normal ADF procedure would have positioned the aircraft at a height of 1 000 ft above the accident site - this corresponds to an altitude of 1 400 ft which was some 540 ft above the authorized minimum descent altitude for the ADF approach. As it was unlikely the impact would have caused some 425 degrees of rotation of an altimeter mechanism and $7\frac{1}{2}$ revolutions of the scale setting knob, the evidence suggested that one altimeter was set at 1046 mb. Similarly, although the evidence associated with the other unidentified altimeter was not proven beyond all doubt, the evidence suggested a setting of 1000 mb which represented a movement of only one tenth of an inch in the mechanism from the correct setting of 1008 mb - a movement which was not inconsistent with impact damage.

With a 1008 mb setting on one altimeter and a 1046 mb setting on the other, the movement of the large pointers on both altimeters would have been synchronized, the difference being one revolution of the pointers. Casual scanning of the instruments could have resulted in the 1 000 ft difference being missed by the crew.

The pilot-in-command reported that the aircraft was at 3 000 ft over the aerodrome. If that was the aircraft's actual altitude then the descent rate to the accident site at an elevation of 395 ft would have been far in excess of the normal rate of descent. If, however, the aircraft had been 1 000 ft lower than that indicated on the altimeter being used for reference, a normal descent procedure would have brought the aircraft to the point of impact.

2.2 Conclusions

(a) Findings

The crew were duly licensed and had current medical certificates. They had been on duty for 10½ hours before starting the flight Algiers to Tripoli.

The aircraft had a valid Certificate of Airworthiness and had been maintained in accordance with established procedures. Its Certificate of Maintenance had been extended from 250 hours to 280 hours in two steps. The weight and centre of gravity of the aircraft were within allowable limits at the time of the accident.

The weather conditions at the time of the accident were IMC. It was a moonless night and the visibility was 1 500 m which was below the minimum visibility of 3 200 m required by the operator for a night landing at Tripoli.

The only navigational aid available to the flight for its approach to Tripoli was the "TPI" NDB which was operating satisfactorily at the time of the accident. The VOR was not available as it required calibration.

No evidence of malfunction or failure of the aircraft, its controls engine or equipment were found. There were no radio altimeters and no flight recorders in the aircraft.

The airline's procedure was to set the QNH on all altimeters and the Tripoli QFE was not requested by the crew. Evidence revealed that the aircraft was flying 1 000 ft lower than it should have been. From the three altimeters which were recovered two gave reliable data and evidence was found that one altimeter was at a setting of 1008 mb and the other at a setting of 1046 mb. As this difference corresponded to a difference in reading of 1 000 ft, the movement of the two large pointers on both altimeters would have been synchronized. This could explain why the 1 000 ft difference in reading was not detected by the crew and why the aircraft was flying 1 000 ft too low.

(b) Cause or Probable cause(s)

The probable cause of the accident was the decision of the pilot-in-command to land while the prevailing visibility was below the Airline's minimum for that airport at night, and for undetermined reasons, the aircraft was lower than the altitude it ought to have been for an ADF approach to the runway in use.

The weather was a contributing factor.

3.- Recommendations

1. Endeavours should be made to install (ILS and GCA) equipment at the International Airports in the Libyan Arab Republic, for facilitation of aeronautical activity.
2. The installation of Runway Visual Range (RVR) equipment at the Libyan International Airports is strongly recommended.
3. The development of the fire fighting and rescue equipment at the Libyan International Airports is urgently recommended.
4. United Arab Airlines is to exercise closer supervision on the conduct of flights with regard to compliance with operating regulations, particularly compliance with the meteorological minima laid down by them.
5. It is recommended that United Arab Airlines should install Flight Recorders in their aircraft type Comet 4C.
6. It is recommended that United Arab Airlines should install radio altimeters in their Comet 4C aircraft.
7. United Arab Airlines is to re-issue their Operations Manual as soon as possible and have it approved by the Civil Aviation Authorities concerned.
8. The Flight Manual is an official document approved by the Civil Aviation Authorities, which forms part of the Certificate of Airworthiness, one copy of which is to be kept on board the aircraft and a duplicate copy is to be retained with the Civil Aviation Authorities of the State of Registry.
9. Airlines of the world must be aware of the fact that human alertness of pilots is at its lowest level in the early morning after a late night departure, and a certain state of mind begins to become apparent, and every effort must be made to re-awaken their energies. This may be helped by raising the level of crew co-ordination, by going over the landing and approach procedures and inviting discussions of their intentions, etc. It is recommended that Operations Departments of the Airlines should issue a Notice to their pilots to this effect.
10. Improved Approach Lighting is to be installed on the main runway of Tripoli Airport.