

No. 21

British Overseas Airways Corporation, Canadair C. 4 (Argonaut), G-ALHE, crashed at Kano Airport, Nigeria, on 24 June 1956. Report by Ministry of Communications and Aviation, Federation of Nigeria. (Also released as C. A. P. 141 by Ministry of Transport and Civil Aviation - U. K.)

Circumstances

The aircraft was operating on a B. O. A. C. scheduled service Lagos - Kano - Tripoli - London. It took off normally at 1721-1/2 hours Greenwich Mean Time from Runway 25 at Kano Airport for Tripoli in moderate rain and climbed to 250 feet. The aircraft then began to lose height rapidly and although the pilot-in-command ordered full power, the descent could not be checked. Notwithstanding the increased power he was unable to prevent it striking a tree and the aircraft crashed about 1-1/2 miles from the end of the runway. Of the 7 crew and 38 passengers aboard, 3 crew members and 29 passengers were killed.

Investigation and Evidence

The aircraft arrived at Kano from Lagos at 1640 hours and refuelling commenced at once. The pilot-in-command discussed with the incoming pilot-in-command the aircraft serviceability and was informed that the automatic propeller synchronisation control was inoperative but full manual control was available. After being told that previous attempts at rectification had been unsuccessful, he decided to proceed without delaying the aircraft.

Earlier the pilot-in-command had seen the meteorological forecast and had noted that it mentioned scattered thunderstorms in the vicinity of Kano. He could see that there was a large thunderstorm centred some distance away to the east-northeast of the Airport, but did not hear any thunder. At the time the sky over the Airport was clear, and it was also clear to the north (on the aircraft's intended track), but to the west he could see one or two cumulus type clouds in the distance.

After his discussion with the incoming pilot-in-command, he noticed that the edge of the overhang from the storm to the east-northeast was over the Airport and the storm itself had moved round to the northeast. This movement had also revealed the tops of more thunderstorms further east. The pilot-in-command,

therefore, decided to consult the meteorological forecaster to ascertain whether there was any line squall reported near the airport and to inquire how fast and in what direction the thunderstorm to the northeast was moving. The duty forecaster informed him that there was a line of thunderstorms about 400 miles to the east but that the thunderstorms in the Kano area were purely local and had no association with any line squall. The pilot-in-command was advised that the thunderstorm to the northeast, being a local storm, would probably move very little but if it did it would move slowly from east to west.

After leaving the forecaster, the pilot-in-command met the navigating officer and told him that they would probably have to go a little way off track to the west after taking-off, to avoid the main belt of rain from the thunderstorm which he estimated would pass about 8-10 miles north of the airport. He mentioned that they had adequate fuel for the flight as they had over 100 gallons more than flight plan requirements. He then informed both the navigating officer and the duty operations officer that he wanted to take off as quickly as possible.

The engines were started at about 1715 hours and the aircraft received taxi clearance from the tower at 1716 hours; permission to taxi to runway 25; QNH 1012 mbs. and surface wind 300° 15 knots. Both pilots set the QNH of 1012 mbs. on their respective altimeters.

During the time the engines were being started, rain began to fall and during the taxi out it became quite heavy though the visibility remained fairly good. The pilot-in-command, looked particularly for any sign of wind gusting and roll type cloud, which are usually associated with the line squall type of storm, but there were no such indications, though the centre of the black area was now very near to the northeast.

In order to save time, most of the pre-take-off checks were carried out and engines run up during the taxi out. Windscreen wipers were operating. When the aircraft stopped at

the threshold of runway 25, the pilot-in-command did not check the visibility with the tower, as he could see clearly to the end of the runway and estimated the visibility as 2 miles. It was now completely overcast and raining heavily and no clear patches could be seen.

At time of take-off, the reported weather conditions on runway 25 were as follows: - cloud 3/8 base 2 500 ft; wind 270° 20 knots; visibility 1 500 yds, moderate rain.

The take-off was perfectly normal and the aircraft became airborne after a run of approximately 2 000 yards.

During the take-off, the visibility decreased owing to the heavy rain on the wind-screen which caused the pilot-in-command to fly on his instruments after the aircraft became airborne. At no time before taking-off or during the take-off did the pilot-in-command have any misgivings about the conditions or consider abandoning the take-off. He had previously taken-off on several occasions in weather conditions that had appeared to be of a similar nature.

Note. - All heights in this report are actual heights above the official Reference Point of the airport, which is the highest point on runway 25 (1 575 feet a.m.s.l.). Both pilots in their evidence gave QNH heights and the heights given in the report are the difference between their altimeter readings and 1 575 feet.

After taking-off the undercarriage was retracted, and when the aircraft passed over the end of the runway at about 100 feet its airspeed was 125 knots. Shortly afterwards, the pilot-in-command called for the first power reduction to 2 850 rpm and 54" manifold pressure. As the aircraft passed over the end of the runway the pilot-in-command noticed a slight updraught. Before reducing power he had assessed flight conditions and found them quite reasonable with a maximum airspeed fluctuation of 5 knots and felt no tendency for either wing to drop.

A normal climb was made to above 240 feet when the pilot-in-command called for 'Flaps up'. At this time the airspeed was fluctuating 125-130 knots with a rate of climb of 300 feet/min.

The rain was still heavy and there appeared to be more ahead but the pilot-in-command could see a gap to the west-northwest. At this stage (when about 250 feet) the aircraft was seen to disappear into heavy rain.

No sink was noticed by the pilots when the flaps were retracted although the speed dropped and remained steady at 123 knots. The pilot-in-command checked the altitude after the flap retraction and noted it was 260-270 feet; the aircraft was quite level and steady. This situation remained the same for what seemed a few seconds - long enough for the pilot-in-command to think that the airspeed should be building up - when he was horrified to see the indicated airspeed dropping steadily and quickly. He immediately called for full power and eased the aircraft's nose down slightly but by that time the airspeed was down to 103 knots.

Note. - The stalling speed of the aircraft at that time has been calculated as 97 knots indicated airspeed with power on, and 104 knots with power off.

The co-pilot, who had just checked that the engine instrument readings were normal, immediately opened the throttles fully with the rpm still set at 2 850. He did not have time to increase rpm to 3 000 because the master rpm lever was not serviceable.

The application of full throttle did not increase the airspeed, which remained steady at about 103 knots, and there were no unusual reactions to the handling characteristics of the aircraft when increased power was applied.

During the sudden emergency, the pilot-in-command did not find it necessary to adjust the trim of the aircraft, and does not recall experiencing any turbulence or sinking of the aircraft. His sole concern was the low airspeed and neither he nor the co-pilot had time to note what loss of height, or rate of descent, was being indicated by the instruments. The aircraft lost height very rapidly and by the time the co-pilot had fully opened the throttles, and taken note of the rising manifold pressures, he looked out quickly and saw that the aircraft was nearly down to tree-top height in an almost level attitude. After he was satisfied that the aircraft was not losing any more airspeed, the pilot-in-command looked out and saw that it was flying level about 15-20 feet above the ground with a tree directly in its path 100-200 yards ahead and was amazed that the aircraft had lost height so rapidly. He started to bank the aircraft to the right, being careful that his right wing did not touch the ground, and attempted to climb. The aircraft began to respond to the controls but the pilot-in-command was unable to prevent it striking the tree.

Inspection at the scene of the accident showed that the first point of impact was with a

35-foot tree about 2 500 yards from the end of runway 25 and approximately 100 yards north of the extended line of the runway. The aircraft had struck the tree about 17 feet from the ground with the left wing and the underside of the nose section. The left wing fuel tanks became ruptured and caused fire to break out immediately; the left outer wing after becoming detached came to rest 160 yards from the tree. A second tree about 300 yards from the first was then struck by the left wing root, the left side of the rear fuselage, and the leading edge of the right tail plane. This impact caused the rear fuselage and tail unit to break away and the aircraft to yaw to the left, and third and fourth impacts with trees followed almost immediately. These last two impacts caused the break-away of the remaining portion of the left inner wing; the rear passenger cabin to fail under side loading, and the aircraft to disintegrate as it swung around to the left. Wreckage was scattered forward over a distance of 140 yards and the right wing broke into three sections. The main wreckage sustained extensive fire damage and the forward fuselage and cockpit were burned out.

The main undercarriage and nose wheel were found in the fully retracted and locked-up position. Examination of the flap operating mechanism which was severely damaged showed that the flaps were almost certainly in the retracted position. The flying control system was severely damaged but no evidence of pre-crash failure was revealed.

All instruments had suffered incineration and, therefore, provided little useful evidence but the left side cockpit altimeter was found set to 1012 mbs.

Detailed examination of the four engines revealed no mechanical defect. The domes of the four propellers were removed and the position of their rotating cam pistons checked. The angles of the blades of N^os. 1, 2 and 4 were found to be in the fine pitch range and N^o. 3 had moved into the feathering range due to crash damage. The engine reduction gear casings in each case had been torn out and were still attached to the propellers; from this evidence and from the damage suffered by the blades of each propeller, it was apparent that all were under a high degree of power on impact.

The Kano weather conditions from 1600 - 1800 hours on 24 June were as follows:-

"At 1600 Greenwich Mean Time there were two thunderstorms in the vicinity of Kano, one about ten miles to the northeast

of the airport and the other about six miles to the southwest. Both were moving slowly towards the southwest and by 1700 GMT the former lay a mile or two to the northeast with an associated cloud overhang extending over the airport itself. Moderate rain from this overhang started to fall at the Terminal Building at 1714 GMT and ended at 1722 GMT. The main centre of the thunderstorm passed a little to the north of the airport but a new cell appears to have developed in the overhang which gave heavy rain and squalls over the western half of the airport at about 1720 GMT and moved westwards. A probable synoptic map of the wind and rain at and near the airport, based upon official observations at the Terminal Building and Temporary Tower and upon lay evidence elsewhere, is given as Figure 13. The evidence of witnesses in the area south and west of the end of the runway establishes beyond reasonable doubt that a strong easterly squall with associated heavy rain was experienced there, though instrumental evidence is lacking. A probable vertical cross section through the runway-line of the wind is given as Figure 14."

"The strong wind and heavy rain from the new cell appear to have reached the ground as the aircraft was taking-off. The surface wind from this cell would fan out from the centre, but the easterly winds in the western sector would be considerably stronger than the westerly winds in the eastern sector because of the momentum brought down from the easterly air current prevailing above about ten thousand feet. This is the normal experience in squalls in this region at this season of the year."

"Initially, the aircraft would experience a moderately enhanced head wind, which is suggested by the evidence of the captain ('up-draft') and a passenger ('air pocket'). This would rapidly change to a strong tail wind, with possibly an element of down-draft, though it is improbable that any significant downdraft was experienced near the surface."

"There would probably have been a pressure rise of the order of 2-3 millibars within the cell which would have caused the altimeter of the aircraft to indicate a height 50-100 feet lower than the true height; that is, the aircraft would have

actually been 50-100 feet higher than was registered on its altimeter."

"The relatively sudden change of wind from a moderate head wind to a strong tail wind experienced in the cell would cause a corresponding decrease in the airspeed of the aircraft."

The Board gave close consideration to the question as to whether the pilot-in-command was justified in commencing the flight in the weather conditions that obtained at the time of take-off. That he had taken care to ascertain the nature of the approaching storm is clear from the questions that he posed to the meteorological forecaster. He was mainly concerned as to whether the thunderstorm approaching from the northeast was associated with a line squall and how fast and in what direction it was moving. The forecaster rightly assured him that the thunderstorm had no association with any line squall and that it was a slow moving local thunderstorm. The moderate rain that fell at the time of take-off did not cause the pilot any concern, as the conditions were considerably above B. O. A. C.'s minima, and as he had taken-off in as bad conditions on several previous occasions he did not at any time consider the need to abandon the take-off. Neither he nor the forecaster could have been aware that a thunderstorm "cell" was forming close to the west of the airport along the take-off path from runway 25, since the associated vertical cloud development was obscured by lower cloud. Kano Airport was equipped with storm warning radar capable of identifying storms some distance away but incapable of detecting the formation of a thunderstorm cell at close range.

The Board was not aware of any official notification to pilots prohibiting them from or advising them against taking-off in, or in the vicinity of, thunderstorms.

The Board, therefore, was of the opinion that the pilot-in-command was justified in taking-off in the prevailing conditions.

The effect of the weather conditions on the aircraft's performance when it was at a height of approximately 250 feet after taking-off has been closely investigated. It is clear from the meteorological analysis that a thunderstorm cell was developing in the area into which the aircraft was climbing. In the early stages of the climb the aircraft encountered an increased westerly wind component as it passed over the end of the runway. But when it reached approximately

250 feet it became affected by a sudden reversal of wind direction of considerable magnitude accompanied by heavy rain and possibly a down-draught. The effect of these conditions was to cause the aircraft to lose speed relative to the surrounding air, i. e., airspeed, and to lose height rapidly. The situation was aggravated by the fact that the speed of the aircraft had become very close to its stalling speed. Throughout this period, all engines were operating at a high degree of power but had no noticeable effect in preventing rapid loss of height. The approximate path of the aircraft in elevation has been plotted from the take-off point to a point about 150 yards short of the first point of impact, and shows that the descent occurred in a very short period of time - probably within the range 5-15 seconds. It has not been possible to estimate the exact height and point at which the aircraft became affected by the cell conditions and, therefore, the rate of descent is largely a matter for conjecture. The rapid descent was in no way caused by the attitude of the aircraft which remained almost level throughout.

The question as to whether the accident might have been averted had full power been applied, i. e., 3 000 rpm instead of 2 850 rpm, has been carefully considered. If the master control lever of the automatic synchronising unit had been operative, the co-pilot would have been able to apply maximum power with 3 000 rpm in less time than if he had tried to obtain 3 000 rpm by "MANUAL" means, i. e., using the toggle switches for individual rpm control. However, in the event, as an emergency action, he applied full throttle without increasing the rpm and although this action has been timed to take about 3 seconds, he has stated that after applying full throttle and taking note that the manifold pressures were rising, he looked out and saw that the aircraft was nearly down to tree-top height. It seems reasonable to assume, therefore, that had he attempted to obtain 3 000 rpm by manual operation of the toggle switches the accident might have occurred before he could have obtained full power. The Board, having considered all the factors involved, considers that even if the master control lever had been operative, it is a matter of doubt whether the extra power available would have had any marked effect on the aircraft's ability to climb.

Probable Cause

The accident was the result of loss of height and airspeed caused by the aircraft encountering, at approximately 250 feet after take-off, an unpredictable thunderstorm cell which

gave rise to a sudden reversal of wind direction, heavy rain, and possible downdraught conditions.

Recommendations

It is recommended that:-

- (i) the International Civil Aviation Organization (ICAO) should be asked to consider setting up a technical committee to investigate the danger to aircraft taking-off or landing when in close proximity to thunderstorms, and to frame recommendations to member States for the safer operation of aircraft in such conditions and,
- (ii) as an interim measure, all pilots should be warned of the danger of taking-off or landing when thunderstorms are in the vicinity.

The following remarks have been received (25 January 1957) from the United Kingdom Member on the Air Navigation Commission of ICAO concerning recommendation (i):-

"The United Kingdom has given most serious consideration to this recommendation and concluded that there is not sufficient justification for asking ICAO to consider setting up a technical committee. It is the United Kingdom view that there is already a great deal of

information available on the nature of the risks and the real problem is to apply the known lessons. Therefore, instead, United Kingdom action will be as follows:-

- a) to revise the United Kingdom Information Circular N^o. 131/1954 dealing with the effect of thunderstorms on aircraft operations in order to make special mention of the take-off and landing risks shown up at Kano.
- b) to prepare and issue a new Information Circular on the effects of cross-winds, gusts and wind-shear on take-off and landing. This will incorporate a description of the wind-shear effect demonstrated at Kano.
- c) to inform ICAO of these actions with the purpose of enabling ICAO to take any further steps that might seem appropriate but without making a United Kingdom request for compliance with the Board's original recommendation.

The agreement of the Nigerian Government to this proposal has been obtained. Action is in hand now on items (a) and (b) above."

