ACCIDENTS INVESTIGATION BRANCH
Department of Trade and Industry

Dan Air Comet 4 G-APDN. Report on the accident which occurred in the Sierra del Montseny, in the Municipal District of Arbucias (Gerona) Spain on 3 July 1970

Translation of the report published by
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16/71	Brooklands Mosquito Mk II Gyroplane G–AVYW at Tees-Side Airport, Middleton St George, Co Durham, March 1969	January 1972
1/72	Comet 4 GAPDN in the Sierra del Montseny near Barcelona, Spain, July 1970	February 1972

SBN 11 510646 4

1. Investigation

1.1 History of flight

The aircraft was operating a regular Dan-Air charter flight from Manchester to Barcelona. It took off from Manchester for Barcelona at 1608 hrs. The routeing specified on the flight plan was via Airways UA1, UA34, UB31 and Point Berga. Because of ATC delays in the Paris area the aircraft was cleared to proceed via UA25 to the Cognac VOR (1725 hrs) – Agen VOR – Toulouse VOR (1743 hrs), joining UB31 at point 'B'. G–APDN was then cleared by French ATC to descend from FL370 to FL220. At 1753 hrs the pilot established contact with Barcelona ACC on 124.7 MHz and after reporting that he had passed the Spanish frontier requested clearance to descend further; it was cleared to descend from FL220 to FL90.

At 1757 hrs G–APDN reported passing the Barcelona FIR boundary and that it was leaving FL160, and gave an ETA of 1801 hrs for Point Berga. At 1759 hrs the pilot received instructions to contact Barcelona Approach (APP) on 119.1 MHz; a few seconds after changing to that frequency G–APDN was instructed to turn left on to heading 140°. The pilot acknowledged the turn and reported that he was leaving FL130, and immediately afterwards gave an ETA for Sabadell of 1807 hrs. At 1800 hrs APP requested confirmation of this estimate and the pilot corrected it to 1805 hrs. On receiving this information, APP cancelled the turn on to 140° and told the pilot to proceed to Sabadell. At 1801 hrs, G–APDN reported leaving FL100 for FL90. APP enquired whether it had DME on board and the pilot replied that it did not. G–APDN was then cleared to descend to FL60. At 1802 hrs, APP instructed the pilot to turn left on to 140°. The pilot acknowledged this instruction and informed ATC that he was leaving FL85 for FL60. Immediately after this transmission, APP requested confirmation that G–APDN was passing Sabadell, and the pilot replied 'in about 30 seconds'; 15 seconds later the the pilot said 'Barcelona, G–APDN passing Sabadell'. APP acknowledged the message and added 'radar contact, continue descent to 2,800 feet, altimeter 1017, transition level five zero'. At 1803 hrs G–APDN requested information on the duty runway, APP replying that the duty runway was 25, which the pilot acknowledged. At 1805 hrs, APP requested aircraft altitude and G–APDN reported passing 4,000 feet. At 1807 hrs APP called the aircraft for confirmation that it was still on course; G–APDN did not reply to this transmission, nor to other calls which were subsequently made.

The site of the accident was: Latitude 41°47′ 45″ North, Longitude 02°27′ 34″ East, and it occurred between 1805 and 1806 hrs, in daylight. The altitude of the site is about 3,900 feet.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Others*
Fatal	7	105	-
Non-fatal	-	-	-
None	-	-	-

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

Destruction of 125 acres of a privately owned beech wood, valued at approximately 25,000 pesetas.

1.5 Crew information

Captain Alexander George Neal, aged 48, held a valid British Airline Transport Pilot's Licence, with a current instrument rating, endorsed to fly Comet, Britannia and HS104 aircraft in command. His licence was issued on 6 February 1967 and was valid until 5 February 1972. He passed his last instrument rating renewal flight test on 17 March 1970. He passed his last periodic medical examination on 3 March 1970 and there were no medical restrictions on his licence. Captain Neal was trained as a pilot in the Royal Air Force and had previously been employed as a first officer by British Eagle. He joined Dan-Air as a first officer in March 1969 and was promoted to captain in May 1970. At the time of the accident he had flown a total of 7,427 hours as a pilot. He had accrued a total of 605 hours on Comet aircraft, 29 hours being in command. The flight on which the accident occurred was his first flight to Barcelona as commander. Previously he had made one flight into Barcelona, on 19 May 1970 during his command and route check.

First Officer David Shorrock, aged 41, held a valid British Airline Transport Pilot's Licence endorsed for Comet, Britannia and BAC 1-11. His licence was issued on 18 July 1968 and was valid until 17 July 1973. He passed his last instrument rating renewal flight test on 18 March 1970. He passed his last periodic medical examination on 26 June 1970. He was required to wear spectacles to correct his near vision when exercising the privileges of his licence. Mr Shorrock was trained as pilot at a civilian flying school and had previously been employed by British Eagle. He joined Dan-Air as a first officer on BAC 1-11 aircraft in April 1969 and converted to the Comet in March 1970. At the time of the accident he had flown a total of 4,765 hours as a pilot of which 189 had been in Comet aircraft.

The flight engineer, Mr David Walter Stanley Sayer, aged 40, held a British Flight Engineer's Licence endorsed for Comet 4 and DC-7B aircraft. His licence was issued on 20 August 1969 and was valid until 21 August 1970. He passed his last periodic medical examination on 7 August 1969. Mr Sayer was originally a ground engineer with Dan-Air before qualifying as a flight engineer on DC-7B aircraft in July 1967. He converted to the Comet 4 in December 1969. At the time of the accident he had flown a total of 1,275 hours as a flight engineer, 218 hours being in the Comet 4. He was considered to be a very competent engineer.

Air Hostesses:

Miss S Hinde, Miss H P Barber, Miss C A Maddock and Miss A Vickers.

1.6 Aircraft information

G–APDN was a standard production HS Comet 4 originally acquired by BOAC in April 1959; Dan-Air bought it from that company in 1969. The certificate of airworthiness was last renewed in the transport category (passenger) on 13 May 1970 and was valid until 12 May 1971. Although the original of the aircraft's certificate of airworthiness could not be recovered, the British commission states that the certificate was in order.

A certificate of maintenance was issued by Dan-Air Engineering on 11 June 1970, after a Check 1 inspection, valid for 62 days or 638 hours. At the time of the accident the aircraft had flown 257 hours since the certificate of maintenance was issued. The total airborne hours of the aircraft were 25,786. Since manufacture the aircraft had been maintained in accordance with an ARB approved schedule. It has been calculated that at the time of the impact the weight was below the maximum total weight authorised and that the centre of gravity was within the prescribed limits.

The aircraft was equipped with duplicated flight instruments, both general flight instruments and the Smiths flight director system. Each pilot had two radio magnetic indicators (RMI), one for presenting VOR information and the other for ADF. The commander's altimeter was of the three-pointer barometric type, whereas the co-pilot's was of the direct reading digital type incorporating a flasher unit and an altitude switch when the height indicated was below 10,000 feet.

The radio equipment carried by the aircraft was as follows:

Marconi AD 307	HF/RT	duplicated
Marconi AD 305/704	VHF COM	"
Marconi AD 712	ADF	"
Marconi AD 704/706	ILS/VOR	"
Marconi AD 708	MARKER	single
Echo E 160	SEARCH RADAR	"
Marconi AD 2300A	DOPPLER	"
Bendix TRA 61 AL	TRANSPONDER	"
Marconi 28800	SELCAL	"
Ultra UA 56	INTERCOM	"

Examination of the company records shows that the Doppler had been out of action since 20 June 1970. This equipment is classified as an allowable deficiency and is not a mandatory requirement.

There had apparently been a series of defects on number 1 VOR set. On 1 July 1970 a controller socket was replaced. A continuity check revealed an open circuit. This was rectified and the VOR was again serviceable. On 2 July 1970 number 1 VOR would not change frequency. The set was changed and the installation then worked normally, according to information received from the British sources. Although it is impossible to be certain that the VOR set was working properly at the time of the accident, it is certain that after the set was changed the aircraft flew four consecutive sectors, apparently without any defect in the equipment.

1.7 Meteorological information

The Sierra del Montseny, lying some 65 kilometres to the NE of Barcelona Airport, was covered by cloud, due to the phenomenon known as 'barrage' effect. The cloud mass showed little vertical development, consisting of stratus and stratocumulus. On the mountain top, known as Turo de l'Home (1,712 metres) situated about 4 kilometres in a straight line to the south of the accident site, and 500 metres higher, there is a meteorological observatory at which the following data were recorded at the time of the accident: pressure at sea level, 1,018 mbs, falling; temperature 9°C; dew-point temperature, 9°C; wind SW, 10 knots; mist, visibility nil; sky not visible on account of mist; orographic precipitation in the form of intermittent drizzle, 1 litre/metre^2 having been recorded in the last twelve hours.

The condensation level to windward was 600 metres, and the cloud clining to the mountain extending on the leeward side down to levels of between 800 and 1,000 metres. The surrounding valleys, away from the direct influence of the high mountains, showed light to medium cloud cover, with scattered cumulus; visibility was reduced by haze, except towards the coastal regions where visibility could be described as good.

Because of the nature and type of the observed cloud, the light southerly winds both at the lowest atmospheric levels and at mountain-top level, and because of the standard distributions which gave the following upper winds and temperatures, 850 mbs 340° 20 knots 9°; 700 mbs 330° 25 knots 5°; 500 mbs 310° 30 knots 9° and 300 mbs 290° 40 knots 20°; the question of the formation of turbulent air movements and mountain waves has not been taken into account because if they did exist they would have been weak and of no importance to air navigation.

1.8 Navigation aids

There are various aids available in the region for an instrument approach to Barcelona Airport. Those relevant to the accident now being investigated are: Sabadell NDB, Barcelona VOR, Perpignan VOR and Gerona VOR. All these aids were operating normally on the day of the accident.

Barcelona ACC/APP also had ASR-5 radar equipment in use, the main characteristics of which are:

- range 60 nm
- accuracy in azimuth: $\pm 0.5^{o}$ error
- accuracy in range within 3%
- theoretical coverage up to 40,000 feet and from 20,000 feet at 60 nm; 12,000 feet at 50 nm; 5,000 feet at 35 nm; 2,000 feet at 20 nm and 1,000 feet at 10 nm.
- The usable range scales are: up to 6 nm with range circles of 2 nm; up to 10 nm with 2 nm; up to 20 with 2 nm; up to 40 with 5 nm and up to 60 nm with 10 nm.

The obstacle clearance chart (MOCA) is attached as Annex 1. Local instructions for use of the radar are attached as Annex 2. Barcelona VOR underwent routine inspections in flight on 2 April 1970 and 9 September 1970, without any corrective measures being required, as stated in the records of the Calibration Service (Servicio de Calibracion). Sabadell NDB was also inspected in flight as a routine measure on 5 June 1969 and 31 July 1970, its condition being regarded as GOOD by the aforementioned service, only some interference from the NDB CST (Costix)(MAJORCA) being observed in the first of these inspections.

1.9 Communications

Communications between G–APDN and Barcelona Control Centre were clear, with the appropriate terminology being used throughout. According to data exchanged, neither Barcelona ACC nor Barcelona APP noticed any abnormality in the flight of the aircraft. Defects have been observed in the tape recording when ACC was talking on 124.7 MHz. When the frequency was changed to 119.1 MHz communications between G–APDN and APP were properly recorded on the Barcelona Control tape.

1.10 Aerodrome and ground facilities

These are not a factor.

1.11 Flight recorders

The aircraft carried a MIDAS type CMT/SC flight recorder. Using all the traces of the parameters of time, speed, altitude, pitch attitude, heading and vertical acceleration, during the last eight or nine minutes of the flight, the track of the aircraft was reconstructed on the map (Annex 3). This showed a close correlation between the aircraft's manoeuvres and the information exchanged between Barcelona Control and the aircraft, and that the track of the aircraft was not correct, deviating the whole time to the east of airway UB31. The accident occurred at 1805.30 hrs and the aircraft was descending, operating completely normally, at a true airspeed of 410 km/h.

1.12 Wreckage of the aircraft

The accident site was on the beech-covered north-east slopes of the Les Angudes peak (1,704 metres), at an altitude of about 3,800 feet, in the municipal district of Arbucias (Gerona).

The heading of the aircraft before impact was approximately 145°, and its flight path was descending between 5° and 10° as indicated by the path cut through the trees by the aircraft. Later, two goniometers (direction finders) were found which indicated a heading of 142°. On detailed examination of the crash it was ascertained that the longitudinal axis of the aircraft at the moment of impact was at an angle of approximately 45° up from the horizontal, ie roughly equal to the angle of the mountain slope, it being noted that the main side marks were produced by the auxiliary fuel tanks and not by the fuselage. The fuel tanks exploded and started a fire.

1.13 Fire

There was an explosion and fire on impact with the ground.

1.14 Survival

As soon as the site of the disaster was known, amongst those who went to the spot were forces of the Civil Guard of 413 Command, Gerona; No 13 Company of the Fourth Group Ninth Brigade of the Red Cross, Barcelona; 110 firemen from the Municipality of Barcelona, 38 militiamen from the Municipality of Barcelona, 25 Red Cross volunteers from the Barcelona Mobile Squad, personnel from the near-by townships of Viladrau and Arbucias (Gerona) and San Celoni (Barcelona). There were also civil and military authorities from the Provinces of Barcelona and Gerona, and an examining magistrate from Santa Coloma de Farnes (Gerona), provincial medical officers from Barcelona and Gerona and members of the staff of Dan-Air Limited. A British commission was appointed to collaborate with the Spanish authorities in investigating the cause of the accident. There were also British technicians and a pathologist, an Anglican priest, the British Consul and Vice-Consul in Barcelona, along with 77 soldiers with NCO's and Officers of CIR No 9 from San Clemente de Sasebas (Gerona).

Due to the uneven terrain, the steepness of the slope and the dense vegetation, a bulldozer and excavator shovels had to be used to widen paths and open up a new one to facilitate evacuation of the victims. Since the Spanish health authorities reported that 'it was technically impossible for the remains of the bodies to be embalmed and preserved, due to the extreme mutilation and scattering of the remains as a result of injuries of exceptional violence caused by an explosive shock-wave, and that death was presumably instantaneous in every case', the court ordered the bodies to be removed and taken to the municipal cemetery at Arbucias where they were buried.

1.15 Tests and investigations

One spoiler (air brake) was extended and the other was retracted, but it was impossible to establish whether the latter had been closed by the impact, although this appears most likely in view of the manner of operation of these brakes.

The main landing gear was retracted.

No flaps were extended.

Safety belts were in use.

The life-jackets were not removed from their normal position.

The turbine and compressor blades showed evidence of heavy abrasion as a result of their having been functioning normally.

The accident took place at 1805.30 hrs this figure being obtained from data in the flight recorder.

1.16 Procedure followed by Barcelona APP

When the aircraft established radio contact with Barcelona APP on a frequency of 119.1 MHz, the latter in order to identify the aircraft, instructed it to turn on to 140°, then cancelled this turn when the aircraft revised its ETA for the Sabadell beacon; this took place between 1759 hrs and 1800 hrs. Later, at 1802.20 hrs, and for identification purposes, APP again instructed G–APDN to turn on to 140° and the aircraft did so. At about 1802.25 hrs APP asked the aircraft if it was over Sabadell – since APP radar showed an echo with characteristics similar to those which the Comet should produce in terms of direction and speed – and the aircraft confirmed 'passing Sabadell', whereupon the controller authorised descent to 2,800 feet, this altitude being authorised on the 'minimum radar altitudes chart' of Barcelona Control Centre.

1.17 In the investigation into the causes of the accident current ICAO regulations have been borne in mind, particularly paragraphs 3.5.2.2 of Annex 2 and Part II, 1, Note 2 and Part X, 1.6 of ICAO Doc. 4444 (RAC/501/9).

2. Analysis and Conclusions

2.1 Analysis

From a study of the recording tape from Barcelona Control; from the plan obtained from the graph taken from the transcription of the flight data recorder tape (black box) from the wrecked Comet 4, G--APDN (Annex 3); from the reports on the aircraft and its crew; and from the UIR chart for south west France and other documents relating to the flight, it is deduced:

That due to heavy traffic in the Paris area, the aircraft was diverted from the route laid down in the flight plan drawn up in Manchester (UA1, UA34, UB31 and Point Berga), and, on the instructions of French ATC, followed the route Nantes VOR – Agen VOR – Toulouse VOR – Point 'B' (situated on the axis of the airway UB31) – Barcelona VOR. Take-off from Manchester was planned for 1600 hrs, but took place at 1608 hrs.

The aircraft did not follow airway UB31, which is the route to Barcelona for that zone, since at 1756.18 hrs it was still in the Bordeaux FIR on a heading of 193°, the direction of the above airway being 181°.

At 1757 hrs, the aircraft reported 'over the boundary', which was taken to mean that it was entering the Barcelona FIR (it had already reported this at 1753 hrs, according to the Barcelona ACC tape) and did so approximately 30 km to the east of the centre of airway UB31, still on the previous heading of 193° and giving at that time an ETA for Point Berga at 1801 hrs. This estimate would have been correct if it had been 'ABEAM BERGA' since at its calculated speed of 8 kilometres per minute (according to data from the flight recorder) it would have been 4 minutes away if it had been heading towards Berga; but it was impossible for the aircraft to reach that reporting point, since at 1801.30 hrs it was level with Point Berga and 26 kilometres to the left, still on a heading of 193°.

When radio contact was established on a frequency of 119.1 MHz with APP, the controller instructed the aircraft to turn on to 140°; the aircraft began the turn as shown on the map at Annex 3, only covering a distance of approximately 4.5 kilometres. The pilot revised his ETA for Sabadell, making it 2 minutes earlier. The controller cancelled the turn and it will be observed from Annex 3 that the aircraft gradually cancelled the turn, proceeding on its previous heading from 1802.18 hrs.

At 1802.30 hrs, for identification purposes, APP Barcelona again instructed G–APDN to turn to the left on to 140°; the pilot of the aircraft confirmed this instruction and reported that he was leaving FL85 for FL60. At approximately 1802.48 hrs, at the request of APP, the aircraft reported passing Sabadell, without having reached that point, since it can be observed on the map at Annex 3 that it was still 52 kilometres away. This message, 'passing Sabadell', transmitted by the aircraft, and also the fact that by coincidence the APP controller had observed an echo on the radar screen over Sabadell, led to the aircraft being informed that radar contact had been made. Neither Barcelona ACC nor the Aeroclub of Sabadell have been able to clarify the reasons for the above-mentioned echo, but this does not rule out the possibility that it was caused by an aircraft flying over Sabadell on a VFR flight plan. At this time the controller authorised descent to 2,800 feet, the minimum altitude indicated on the radar chart for this sector.

The bearing and speed of the echo were similar to those expected from a Comet.

At 1803 hrs, G–APDN requested the duty runway and APP replied that No. 25 was in service. This the pilot acknowledged. At 1805 hrs, APP requested an altitude reading and the aircraft replied 'passing 4,000 feet'. At 1807 hrs, APP requested G–APDN to confirm it was maintaining its heading, but the aircraft did not reply.

The displacement of the aircraft's track to the east cannot be attributed to deviations of the Barcelona VOR signals, since if such a considerable defect had existed it would have been detected by numerous flights which have used and continue to use this VOR. Furthermore as has previously been stated, on 2 April 1970 the appropriate official service carried out a check and found the equipment within the permitted tolerances and therefore no adjustments were made.

2.2 Conclusions and probable causes

2.2.1 From the time the aircraft reported passing Toulouse VOR (if correct) it can be seen that it did not continue on UB31 after the BRAVO intersection point, but followed a line considerably to the east of that airway. This error persisted right up to the moment of the accident, and the information on ETAs and times of passing Point Berga and Sabadell NDB was also incorrect, as was the time given for passing the UIR boundary which was given twice with an interval of some 3 minutes.

2.2.2 Barcelona VOR was functioning correctly according to information from the Flight Air Inspecting Services, and from the absence of unfavourable reports on the functioning of the radio aid in question.

2.2.3 Consequently, the aircraft's continuing displacement to the east could have come about as a result of some defect of the aircraft equipment, bearing in mind that from Toulouse VOR positions had to be determined by intersection of radials.

2.2.4 The pilots should have reported to Barcelona APP that they were passing to the east and not above Point Berga. The fact that this information was not given, together with an inexact ETA for Sabadell, made it difficult for the controller to identify correctly the aircraft on the radar screen.

2.2.5 To sum up, it can be deduced that the combination of erroneous information regarding reporting points, together with the existence of a radar echo over Sabadell NDB (coinciding with the report from the aircraft of passing that reporting point), led both the aircraft and APP to believe, erroneously, that the aircraft was already over Sabadell; this was an involuntary error (on both sides: ATC and aircraft) which was physically impossible to correct when Air Traffic Control realised it.

3. Recommendations

3.1 Emphasis should be given to the need for commanders of aircraft flying on a new route to verify successive positions of the aircraft using all the aids available on board, rather than relying on the evidence of any one of them.

3.2 It would perhaps be desirable that the rules laid down by ICAO for radar identification should be revised, to prevent similar situations occurring. The Spanish authorities, for their part, have already made suitable provision in this respect, so that identification can be properly checked by more than one method.

3.3 Radio installation charts which are used for navigation purposes (radio navigation charts) should incorporate spot heights of the significant points along the route to be followed.

Madrid October 1971