
Loss of separation, Boeing 737-300, D-ABEK and Gulfstream IV, N77SW

Micro-summary: Loss of separation on descent between a Boeing 737 and Gulfstream IV.

Event Date: 1999-02-26 at 0830 UTC

Investigative Body: Aircraft Accident Investigation Branch (AAIB), United Kingdom

Investigative Body's Web Site: <http://www.aaib.dft.gov/uk/>

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Boeing 737-300, D-ABEK and Gulfstream IV, N77SW

AAIB Bulletin No:	10/99	Ref:	EW/C99/2/6	Category:	1.1
Aircraft Type and Registration:		1)	Boeing 737-300, D-ABEK		
		2)	Gulfstream IV, N77SW		
No & Type of Engines:		1)	2 CFM56-3-B turbofan engines		
		2)	2 Rolls Royce Tay Mk 611-8 turbofan engines		
Year of Manufacture:		1)	1991		
		2)	1993		
Date & Time (UTC):			26 February 1999 at 0830 hrs		
Location:			Near Lambourne VOR		
Type of Flight:		1)	Public Transport		
		2)	Private		
Persons on Board:		1)	Crew - 6 - Passengers - 95		
		2)	Crew - 3 - Passengers - 3		
Injuries:			Crew - None - Passengers - None		
Nature of Damage:			None		
Commander's Licence:		1)	Airline Transport Pilot's Licence		
		2)	Airline Transport Pilot's Licence		
Commander's Age:		1)	43 years		
		2)	31 years		
Commander's Flying Experience:		1)	8,000 hours (approximately) (of which 4,500 were on type)		
			Last 90 days - 60 hours		
			Last 28 days - 80 hours		
		2)	3,700 hours (of which 800 were on type)		
			Last 90 days -60 hours		
			Last 28 days -30 hours		
Information Source:			AAIB Field Investigation		

This incident involved a loss of separation, in Class A controlled airspace IMC, between a Boeing 737-300 (B737) and a Gulfstream IV (GIV). The B737 was inbound to London Heathrow Airport from Munich and the GIV was inbound to Farnborough Airport from Istanbul. The two aircraft

were under the control of different controllers. The loss of separation generated an ACC Short Term Conflict Alert (STCA) and both aircraft received Traffic Alert and Collision Avoidance System (TCAS) Resolution Advisories (RA). Separation was regained after a TCAS manoeuvre by the B737 and a change of heading by the GIV.

History of flight

The GIV commander first contacted the Lambourne Sector Controller (LAM SC) at 0824 hrs and reported "FLIGHT LEVEL 150, HEADING 270". The call was acknowledged and he was asked to fly a heading of 275° with which the co-pilot, who was the handling pilot, complied. The next contact with the GIV from LAM SC was made at 0828 hrs clearing the aircraft for descent to FL120. The GIV commenced descent at 2,000 feet/min and maintained an airspeed of 300 kt.

The B737, also with the co-pilot handling, contacted the Heathrow Intermediate North Director (LL INT N) at 0822 hrs and reported approaching the Lambourne hold levelling at FL120. At 0823 hrs LL INT N instructed the B737 to descend to FL110 in the hold. This instruction received no response but when it was repeated the pilot said "WOULD APPRECIATE TO MAINTAIN FL120 AS LONG AS POSSIBLE TO STAY CLEAR OF CLOUD". The request was approved and the B737 remained in the hold at FL120.

At 0830 hrs the B737 was turning outbound in the hold onto an easterly heading when the commander reported that he had TCAS traffic at one o'clock descending. The LL INT N controller responded immediately by giving an avoiding action descent to FL110. The B737 then transmitted again saying that he was executing a TCAS manoeuvre, climbing to FL125. At 0831 hrs the B737 was re-cleared by LL INT N for descent to FL120 after having been informed that he was now clear of traffic.

At 0830 hrs the LAM SC and the GIV commander transmitted almost simultaneously but the last part of a transmission from the GIV was heard saying that he had a "TRAFFIC WARNING" ahead. The LAM SC gave the aircraft an "IMMEDIATE LEFT TURN" to a heading of 180°. He then repeated this instruction including the phrase "AVOIDING ACTION". The GIV commander replied that they were already in the left turn and climbing. Half a minute later the GIV reported that they were clear of the traffic and maintaining FL116. The GIV was subsequently cleared for a right turn to a heading of 240° and for a climb back to FL120.

Air Traffic Control

The LAM SC had held a radar validation for his position for 18 years. He reported for duty at 0700 hrs and had taken one 20 minute break at 0730 hrs. The LL INT N controller also reported for duty at 0700 hours and had held a radar validation for his position for 3 years. He also had a break and resumed his task at 0800 hrs.

The standard route for traffic inbound to Farnborough from the East is from the reporting point LOGAN to LAM VOR and then to CPT VOR. LAM VOR is one of several holding areas for traffic operating in the London Terminal Control Area (LTMA). There are also a number of airways which cross LAM VOR. In this complex airspace transiting aircraft are frequently given a radar heading and handled on a tactical basis. Separation for traffic in the area is normally achieved in the vertical plane not the horizontal.

The plan on this occasion was to route the GIV through the LAM holding area ensuring that there was a vacant level to accommodate the aircraft. The LAM SC is provided at his position with a closed circuit television which depicts the LL INT N controller's flight progress slips allowing him to monitor the progress of flights released to Heathrow. The progress strip in this case showed him that the B737 had been cleared to FL110 but had not yet vacated FL120. He decided to use FL 120 for the GIV and made a mental note not to issue a clearance until the level was vacated. Having organised this he was able to plan the levels for the next few aircraft inbound to the hold at LAM and was engaged on this task at the time of the traffic conflict.

Meteorology

An aftercast was obtained from The Meteorological Office at Bracknell which showed a weak frontal system moving slowly across the area giving rise to an overcast layer of cloud with a base around 10,000 feet and tops around 12,000 feet. The GIV pilot reported that he entered an overcast cloud layer at some time on his descent from 15,000 feet to 12,000 feet and remained in cloud throughout the incident. The B737 pilot had initially been clear of cloud at 12,000 feet but at the western end of the holding pattern he entered cloud and remained in IMC conditions to the time of the incident. The regional QNH was 1013 mb.

Flight recorders and radar data

London Area and Terminal Control Centre (LATCC) provided the AAIB with recordings of the radar information available to both air traffic controllers. LATCC also provided position information for each aircraft at one second intervals, derived using specialist software that correlated and weighted all the available recorded radar data.

Neither of the Cockpit Voice Recorders (CVR's) was replayed as they had insufficient recording duration to retain information on the incident. The Flight Data Recorders (FDR's) from both aircraft were replayed; the data on the B737 was overwritten as the aircraft had flown in excess of 25 hours since the incident. The GIV recorder, which was a modern solid state type, contained data on the entire incident flight. The data showed that the GIV responded to the left turn instruction with an initial rate of roll of 10°/sec. During the manoeuvre the aircraft reached a maximum recorded bank angle of 63° and 1.78G, peak values may have been in excess of these. The parameters recorded also included aircraft position information which was used to refine further the position data obtained from radar. Some TCAS data was recorded, however, it was insufficient to enable the TCAS information provided to the flight crew to be determined.

The recorded FDR data, the ATC recordings and the radar information were time correlated and combined to produce an animated time history of both aircraft tracks and their communication with ATC. This animation was used to assist with the understanding and analysis of the incident. The analysis and projections suggested that the B737 would have passed just behind the GIV if no action had been taken. In fact with the manoeuvres carried out by each aircraft the GIV passed through the B737's 12 o'clock position at a range of 1.3 nm with a 400 feet vertical separation.

Warning systems

There was no requirement for aircraft operating in UK airspace to be fitted with Airborne Collision Avoidance System (ACAS) at the time of the incident but such systems will be mandatory from 1 January 2000. However, both aircraft were fitted with Traffic Alerting and Collision Avoidance System (TCAS) equipment that presented information on the primary flight and navigation

displays. Pilots are required to respond immediately to TCAS RAs and to advise ATC as soon as practicable of any deviation from a clearance. The B737 aircraft initially received an amber Traffic Advisory (TA) showing an aircraft at one o'clock position and 400 feet above. This was rapidly followed by a red Resolution Advisory (RA) of "CLIMB CLIMB CLIMB" demanding a rate of 1,500 fpm. Once the manoeuvre had been initiated the RA changed to "MONITOR VERTICAL SPEED" followed by "CLEAR OF CONFLICT." The GIV received a TA showing traffic at one o'clock and 400 feet below, rapidly followed by a RA. The GIV pilots were unable to recall the TCAS instruction given in the RA because they were already following the avoiding action instructions given by the controller. Both aircraft received their RAs, and ATC received the STCA, at approximately the same time. The time from the first alerts to the estimated point of minimum horizontal separation was around 25 seconds.

The STCA system used in the London area automatically alerts controllers to a potential conflict via the radar display. There are two possible levels of alert, in this case the display went immediately red indicating a high severity conflict. The present STCA limits are set to give optimum warning while minimising the level of nuisance alerts; an excessive number of unnecessary alerts would degrade the operational effectiveness of the system. Work is at present being undertaken to enhance the STCA system with a view to extending the alerting period that it provides.

A pilot in receipt of conflicting instructions from ATC and from TCAS is required to respond to the TCAS directions and to advise ATC as soon as practicable. The controller resumes responsibility for separation once the pilot advises that he has returned to his assigned clearance or accepts another clearance.

Discussion

The two ATC sector controllers on the morning of the incident described their respective workloads as moderate. There were no unusual operating features and the only deviation from the normal routine was the request made by the B737 commander to remain in the hold at FL 120 instead of accepting the descent clearance to FL 110. This request, although uncommon during a busy time, should not have caused any disruption to normal ATC procedures and did not appear have done so on this occasion.

The fact that the B737 was turning in the holding pattern to an easterly heading and the GIV was on a westerly heading meant that the closing speed was high and the detection by the STCA and by the TCAS systems was at a late stage. This was an example of a case where the geometry of the conflict led to undesirably short warning times for both crews and controllers, but the prompt avoidance manoeuvres carried out by the two aircraft prevented a closer encounter.

The LL INT N controller had no knowledge of the traffic conflict until the STCA activated. His response was both rapid and logical as he attempted to increase the vertical separation between the aircraft. This gave rise to the situation whereby the TCAS instruction and the controller's instructions were in opposition. The B737 pilot responded correctly by following the TCAS instruction and reported his action to ATC and the controller responded correctly giving the B737 traffic information.

The LAM SC followed normal practice by allocating the GIV a radar heading which would take the aircraft just to the south of LAM VOR. He made a mental note regarding the potential conflict at FL120 but then diverted his attention to another task. When he subsequently issued the GIV with a

descent clearance he overlooked the potential conflict. On being alerted by the STCA he issued prompt avoiding action instructions to the GIV to turn left, to increase the lateral separation of the aircraft. The GIV co-pilot, already concerned about another aircraft after receiving the "traffic" advisory, responded immediately to the instruction to turn left. The commander of the GIV initially reported to ATC on carrying out the turn that the aircraft was climbing. It is likely that as non handling pilot he was initially confused as to the situation of the aircraft because of the large bank angle and G force that the aircraft was experiencing whilst in IMC.

It is worth noting a difference between individuals operating as air traffic controllers and as pilots. An airline pilot operates in a multi-crew environment where his actions are continuously cross-checked by another person. In the present air traffic management system there can be fewer cross checks of the actions of a controller by a second person and in the event of an error the system safety net depends on the STCA or TCAS alerts.

The STCA system gave an alert to each controller but one of the limitations of the system is that in order to re-establish separation there must be an ATC transmission giving avoiding action instructions. This will entail a delay and in the event of a crossed or blocked transmission there may be insufficient time for avoiding action to be taken. A pilot is able to respond directly to what he sees on his display in the event of a TCAS RA and for this reason it is the primary means of avoidance once a conflict has occurred. In the event both systems contributed to preventing a more serious incident.

The investigation examined the desirability of routing LTMA crossing traffic through a holding area. Under the present system, traffic is routed through such areas on a tactical basis. Experience has shown this to be the most effective way of handling such traffic, offering ATC maximum flexibility and enabling optimum use to be made of the airspace. If such traffic was not to be routed through holding areas it is likely that flexibility would be lost within the air traffic management system. Furthermore, any other procedure, short of the total exclusion of crossing traffic from such airspace, could present as many, if not more potential conflicts.