
Ground collision, Airbus A340, A40-LB and Boeing 757-236, G-BIKG, 23 November 1995

Micro-summary: Collision between a 747 and 757 while taxiing at Heathrow.

Event Date: 1995-11-23 at 1031 UTC

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

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

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Airbus A340, A40-LB and Boeing 757-236, G-BIKG, 23 November 1995

AAIB Bulletin No: 7/96 Ref: EW/C95/11/4 Category: 1.1

Aircraft Type and Registration: i) Airbus A340, A40-LB

ii) Boeing 757-236, G-BIKG

No & Type of Engines: i) 4 CFM56-5C turbofan engines

ii) 2 Rolls-Royce RB211-535C turbofan engines

Year of Manufacture: i) Unknown

ii) 1983

Date & Time (UTC): 23 November 1995 at 1031 hrs

Location: Heathrow Airport

Type of Flight: i) Scheduled Public Transport

ii) Scheduled Public Transport

Persons on Board: i) Crew - 17 Passengers - 241

ii) Crew - 7 Passengers - 113

Injuries: i) Crew - None Passengers - None

ii) Crew - 2 minor Passengers - None

Nature of Damage: i) Left winglet

ii) Rudder and fin

Commander's Licence: i) Airline Transport Pilot's Licence

ii) Airline Transport Pilot's Licence

Commander's Age: i) 43 years

ii) 53 years

Commander's Flying Experience: i) Approx 8,000 (of which 600 were on type)

Last 90 days - 140 hours

Last 28 days - 55 hours

ii) Total 11,700 (of which 320 were on type)

Last 90 days - 175 hours

Last 28 days - 44 hours

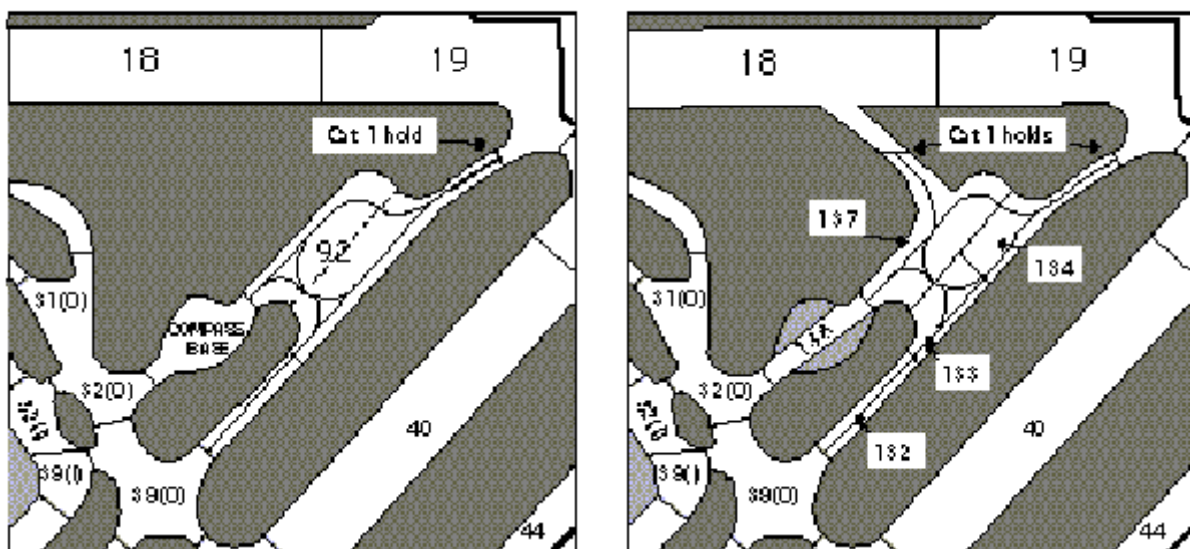
Information Source: AAIB Field Investigation

Background

The runways and taxiways at Heathrow Airport are divided into 'blocks' with each block having an identification number. Surrounding the central area are two orbital taxiways which are essentially parallel; blocks on these taxiways also have the suffix 'I' for the inner taxiway and 'O' for the outer taxiway. Holding areas for each runway are located close to the runway thresholds. These contain a wide expanse of paved surface within which aircraft can hold awaiting departure instructions. The width of these areas is such that aircraft cleared to enter the runway can taxi past other aircraft awaiting departure instructions.

The accident occurred in the holding area for Runway 27 Right. During the autumn of 1995, a new access to Block 18 of Runway 27R was constructed as shown below. With the introduction of this taxiway the old holding area (Block 92) was subdivided into three new blocks and the compass base was moved to another part of the airport. Each block has a taxiway centreline marked on the ground by a yellow painted line and green lights. (For clarity only the centrelines within the holding area are shown in the diagram below). At the end of each block there are stop lines and red lights across the centrelines marking the extremity of the block.

RUNWAY 27R HOLDING AREA BEFORE OCT 95 RUNWAY 27R HOLDING AREA ON 23 NOV 95



The boundary line at the top of Block 137 in the right hand diagram is also the Cat I Hold line. The line was painted parallel to the runway and 105 metres from its centreline. This is also the edge of the runway strip. (The runway strip is defined in CAP168; essentially it is an area enclosing the runway which must be kept clear of obstacles). There was also a Cat II/III Hold parallel to and 137 metres from the runway centreline.

Within the holding area (the old Block 92), the parallel portions of the taxiway centrelines were 86 metres apart. The longest wingspan routinely encountered at Heathrow is 64.44 metres which belongs to the Boeing 747-400. Consequently, when on parallel taxiways, any aircraft can safely pass another if each remains over its respective centreline. At Heathrow the centrelines have to be sited so that when the cockpit of the most critical aeroplane for which the taxiway is intended is over the centreline, the distance between the outer edge of the main wheels and the edge of the pavement is at least 4.5 metres.

Air Traffic Departure Sequencing

During busy times at Heathrow there can be a sizeable queue of aircraft waiting to depart. To improve the departure rate, ATC sequence departures so that aircraft depart in quick succession but on different routes. There are also the added complications of meeting approved departure times (known colloquially as ATC slot times) and wake turbulence separation. There is no requirement for wake turbulence separation between departing aircraft of the same wake turbulence category or when a heavier category aircraft departs behind a lighter category aircraft. However, when an aircraft departs behind another of heavier category, it must wait for two minutes if they depart from the same position on the runway or for three minutes if it departs from an intersection.

To enhance the departure movement rate, Heathrow ATC issues line-up clearances to aircraft based on the departure of the aircraft ahead of them in the sequence. (A typical instruction might be "SPEEDBIRD EIGHT, AFTER THE SYRIAN AIR SEVEN TWO SEVEN DEPARTS, LINE UP ON TWO SEVEN RIGHT"). However, the aircraft ahead in the sequence may not be the aircraft directly in front of the aircraft receiving its line-up clearance; the preceding aircraft in the sequence may be to one side or behind or in another block. In practice aircraft crews may be given line-up clearance when they are third or more in the departure sequence. This has the advantage of minimising runway occupancy time by 'pre-clearing' aircraft to taxi onto the runway as soon as the preceding aircraft has vacated the appropriate runway block. By cutting down the runway occupancy time, the departure flow rate is improved.

Because the departure sequence cannot be determined before aircraft are cleared to taxi, they invariably arrive at the holding area in a less than optimum departure order and ATC expect aircraft to pass beside one another in the holding area. The reason for building the new taxiway between the holding area and runway 27R was to improve ATC's ability to vary the departure sequence by extracting aircraft from the holding area through an additional runway access point.

The accident

The accident occurred in daylight, fine weather and good visibility. The Boeing 757 callsign Shuttle 6N pushed back from stand A3 at 1013 hrs with no ATC slot time required. After starting engines, the aircraft was cleared by the ground movement controller to taxi via the outer taxiway for runway 27R. The A340 pushed back from stand L3 at 1010 hrs to make good its approved departure time of 1020 hrs and received the same clearance from the ground movement controller but, having a greater distance to taxi, was behind the Boeing 757 on its way to the holding area.

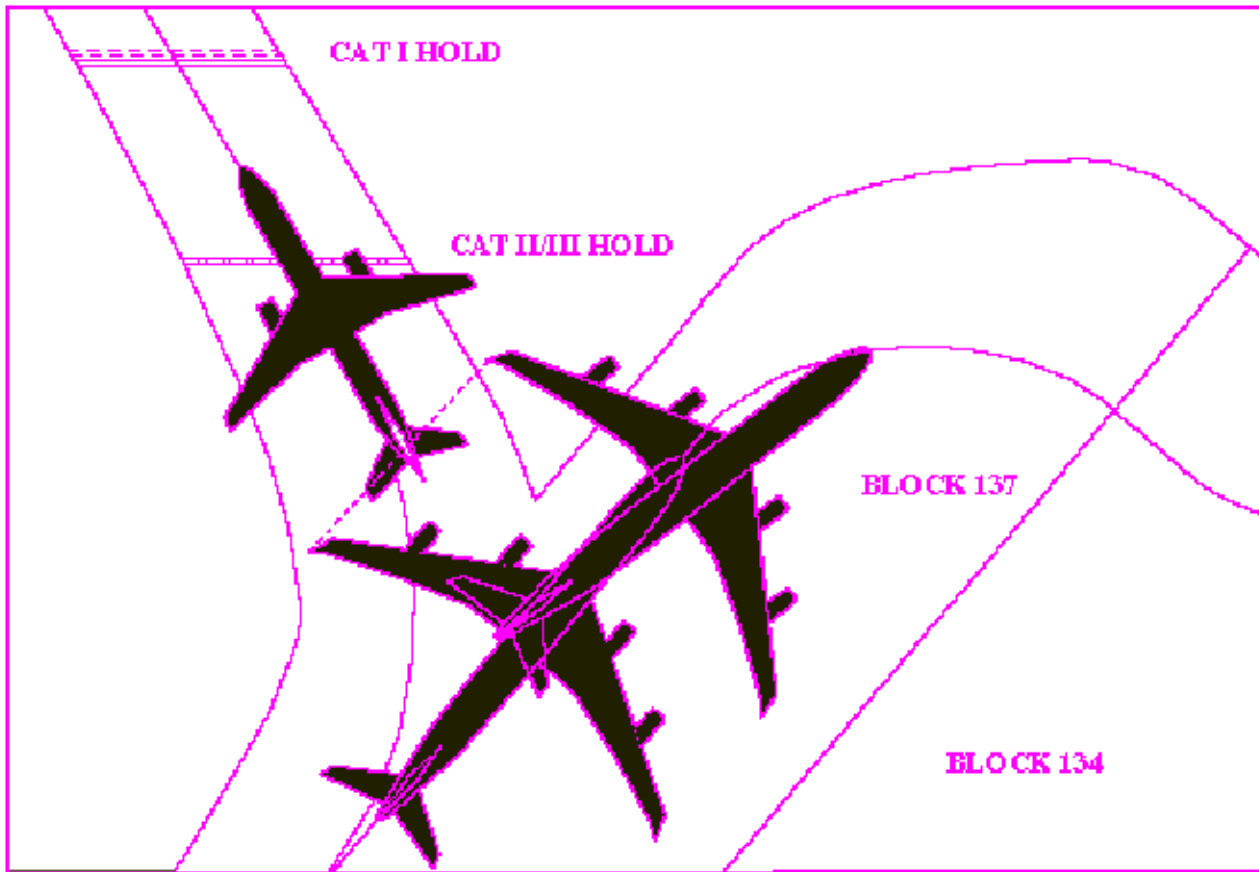
Both aircraft entered the holding area via Block 32(O) where there was a queue of aircraft waiting to depart. At 1020 hrs the crew of Shuttle 6N were instructed to "HOLD FOR BLOCK 18". The aircraft was taxied by the co-pilot from the holding area into the taxiway of Block 137 where it remained, stationary, until the accident. The A340 was behind several aircraft including an Aer Lingus Boeing 737 and an MD11. Between 1023 and 1031 hrs, ATC made several requests to pilots to taxi into a different position. These calls took the forms of "START PULLING FORWARD NOW"; "PULL FORWARD BEHIND THE ALITALIA"; "PULL OVER TO THE LEFT" and "PULL FORWARD AS FAR AS POSSIBLE PLEASE". At 1025 hrs the controller asked the MD11 crew to "PULL OVER TO THE RIGHT HAND SIDE BEHIND THE SYRIAN AIR" to which its pilot replied "YOU HAD US PULL UP BEHIND THE AER LINGUS SO WE CAN'T NOW". Next the controller asked the crew of a Boeing 757 behind the A340 whether they could manoeuvre for a Block 18 departure but the crew replied that they were unable to do so. They were then instructed to "PULL OVER TO THE RIGHT HAND SIDE FOR A FULL LENGTH".

During the next five minutes an A320, a Boeing 727 and a Boeing 757 departed from the full length and a Boeing 737 departed from Block 17. Another Boeing 737 began its take-off run from the full length after the departure from Block 17. As it did so, the MD11 followed by the A340 began to move forward. At 1031 hrs the left hand wingtip of the A340 struck the Boeing 757's rudder and fin.

The impact was felt in both aircraft. In the Boeing 757 two cabin crew standing by the aft galley received minor injuries when they lost their balance but no one on board the A340 was injured. After the collision the A340 commander taxied a few feet further forward to ensure that his wing tip was clear of the 757's APU. Both aircraft then remained parked whilst the emergency services were summoned by ATC. The Airport Fire Service arrived shortly after the accident and supervised the deplaning of all the passengers via mobile airstairs and into coaches.

Measurements

Measurements taken after the incident showed that the nose landing gear of G-BIKG was 23.6 metres (along the taxiway centreline) behind the CAT I stop bar and 8.6 metres ahead of the CAT II/III stop bar. Profiles of the two aircraft imposed on a plan view of the taxiways and holding area are shown below. The diagram shows that, with G-BIKG in its measured position and A40-LB in its final position, the contact measured on the winglet and rudder would have occurred with A40-LB on its taxiway centreline at the point of contact.



Damage

On the B757 most of the damage was sustained on the lower part of the rudder, with further damage to beams and composite fairing panels aft of the fin's rear spar. The rudder itself was split into two parts and was replaced. A number of the rudder attachment bearings were also replaced but there was no evidence of damage to the rear spar of the fin itself. On the A340 most of the damage was limited to the left-hand winglet, with minor scratching and denting damage to the No. 6 slat on the leading edge. The left-hand winglet was removed and the aircraft was despatched without it in accordance with the Minimum Equipment List.

Human factors

Ten minutes before the collision, the Boeing 757 had been instructed to "HOLD FOR BLOCK 18". The co-pilot parked the aircraft with the flight deck beyond the Cat II/III hold line but short of the Cat I hold line. The commander was content with this parking position. He stated (correctly) that the hold line represents a limit not a target and no part of the aircraft should protrude over the line which was painted diagonally across the taxiway. He was also anxious not to get too close to the runway because aircraft departing from the full length would pass close to his aircraft and, should they encounter any directional control problems, he would be unable to get out of their way. The AAIB were unable to find any UK documentation requiring or encouraging pilots to pull forward to the limit of a holding position.

The A340 commander taxied his aircraft by reference to the yellow taxiway lines. He believed that if he followed these lines, his aircraft would remain clear of any obstacles beside the taxiway. He had to hold in Block 137 for a while and there he received clearance to line up after an MD11 in

front of him departed. He was aware of the 757 in the link taxiway leading to Block 18 and also of another 757 on his right. He made no comment to the other two pilots on the flight deck about the proximity of these aircraft and they did not perceive the collision risk. (Neither could have seen the left wing tip from his own seat). The size of the aircraft relative to the holding area and the position of the link taxiway meant that the commander had to start turning right to follow the taxiway centreline at about the time his wingtip approached the parked B757's tail. The commander stated that part way around the right turn he looked to his left at the offending wingtip but it was too late to avoid a collision.

The ATC tower is several hundred metres from Block 137 and the controller was unable to assess the collision risk between taxiing aircraft. He was totally reliant upon the "duty of the commander of an aircraft to take all possible measures to ensure that his aircraft does not collide with any other aircraft or with any vehicle" (The Rules of the Air Regulations 1991, Rule 37).

Neither Heathrow Airport Limited (HAL) nor Heathrow ATC had conducted any studies to determine the collision risks involved in using the new taxiway link which was available to any aircraft regardless of its size. Moreover, no account had been taken of taxiing collision risks when designing the shape and position of the new taxiway and holding points.

Collision Hazard

Studies by the AAIB using scale drawings showed that if an aircraft with a long fuselage was holding in the taxiway of Block 137, there was a very real collision risk whenever an aircraft with a large wingspan followed the taxiway centreline to pass behind it in the same block. For pilots of some large aircraft types, separation between their wing tip and the tail of a parked aircraft is difficult to assess because of the restricted view from the flight deck. For instance, in the A340 the wing tip is 51 metres (167 feet) from the pilot and 41 metres (134 feet) behind him; in Concorde the wing tip is almost abeam the fin. In many contemporary swept-wing airliners a wing tip can only be seen by making a special effort and then only from one pilot's seat. Pilots cannot see the right wing tip from the left seat and vice-versa. Moreover, wing tips can be hard to see through rain spattered side windows (although on this occasion it was not raining) and some aircraft types, notably the ubiquitous Boeings 737, 757 and 767, do not have a white navigation light on the tail; they have one on the trailing edge of each wingtip. They do have logo lights to illuminate the fin but there is no requirement for these lights to be switched on. Consequently, the risk of collision may be greatest in heavy rain or at night.

Airport Design Requirements

The taxiways at Heathrow generally met the design criteria of CAP 168 Licensing Requirements which generally mirror the standards laid down in ICAO Annex 14 - Aerodromes. Both documents specify minimum distances between taxiway centrelines and permanent features such as runways, other taxiways and apron taxiways. The requirements also stipulate that taxiway centrelines must provide a clearance of not less than 20% wingspan between an aeroplane's wing tip and a temporary obstacle when the aeroplane is in the centre of the taxiway. Both documents contained recommended minima for the distance between a taxiway holding position and a runway centreline but only Annex 14 made reference to the distance between a taxiway holding position and an adjacent taxiway centreline. The reference was a recommendation which applied to the clearance between a parked aircraft's nose and a passing aircraft at an intersection of two taxiways; there was no mention of tail to wing tip separation minima.

Airworthiness requirements

Requirements for the view from the A340 flight deck were contained in JAR 25.773 which states: *'Each pilot compartment must be arranged to give the pilots a sufficiently extensive, clear, and undistorted view, to enable them to perform any manoeuvres within the operating limitations of the aeroplane, including taxiing, take-off, approach and landing'*. The requirements also stated that internally, the flight deck windows must have a demisting system which provides sufficient visibility to execute the manoeuvres described above. However, only the windshields have to be externally cleared of precipitation. The requirement was to provide *'a clear portion of the windshield during precipitation conditions, sufficient for both pilots to have a sufficiently extensive view along the flight path in normal flight attitudes of the aeroplane'*. Consequently, aircraft generally do not have screen wiping systems for side windows.

Safety actions

The new taxiway was withdrawn from use immediately after the accident. The CAA then invited HAL and Heathrow ATC to devise procedures for the use of the new taxiway which would minimise collision risks.

HAL appreciated the need to explain to pilots that on the taxiways, following the centreline provided adequate clearance from obstacles but not from other aircraft in the holding areas. There the centrelines represent only the centre of the taxiway route and wingtip clearance from other aircraft is not assured. However, during low visibility operations the green centreline lighting would be used to provide two separate routes to the runway. One route would be via Blocks 136 and 137 to Block 18 and the other would be via Blocks 132, 133 and 134 to Block 19. Under these conditions separation would be assured.

On 7 February 1996 HAL proposed new measures to the CAA for re-opening the taxiway link. Briefly these measures were:

- a. Provision of new information signs at the entrances to each of the four departure holding areas.
- b. Issuing a Class II NOTAM showing the four departure hold areas, explaining their significance in terms of permanent green centreline lighting and reminding pilots that separation from other aircraft is their responsibility in these areas.
- c. Provision on a trial basis of lighting to illuminate aircraft holding in the taxiway of Block 137.
- d. Publication of notices in the UK AIP and NOTAMS encouraging pilots to pull forward to stop bars.

The CAA accepted HAL's proposals on condition that further safeguards affecting the tactical use of the holding area were implemented by the Airport Authority.

The CAA also ordered that the taxiway should not be used until the installation of signs and lighting, agreement on the wording of procedures and notices, and the education of airport users had been co-ordinated with the Authority.

Safety recommendation 96-43

Whilst noting the measures enforced by the CAA, the AAIB were wary of the trend to route all departing aircraft through a common area on different taxiways whilst relying upon pilots to avoid collisions when pilots cannot always see the extremities of their aircraft. Therefore, it was recommended that:

The CAA should, in liaison with the appropriate ICAO committees, consider what action may be taken in the longer term to ensure that flight crews of large public transport aircraft are better able to achieve a positive clearance between their aircraft and others while manoeuvring on the ground.