
Ground collision between Airbus A340-313, 6Y-JMP and Boeing 777-222, N781UA

Micro-summary: While taxiing, this Boeing 777 collides with an Airbus A340.

Event Date: 2004-07-14 at 1254 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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ACCIDENT

Aircraft Type and Registration:	i) Airbus A340-313, 6Y-JMP ii) Boeing 777-222, N781UA
No & Type of Engines:	i) 4 CFM56-5C turbofan engines ii) 2 Pratt & Whitney PW4000 turbofan engines
Category:	1.1
Year of Manufacture:	i) 1992 ii) 1996
Date & Time (UTC):	14 July 2004 at 1254 hrs
Location:	Runway 27L Holding Area, London Heathrow Airport
Type of Flight:	i) Commercial Air Transport (Passenger) ii) Commercial Air Transport (Passenger)
Persons on Board:	i) Crew - 4 Passengers - 273 ii) Crew - N/K Passengers - N/K
Injuries:	i) Crew - N/K Passengers - N/K ii) Crew - None Passengers - None
Nature of Damage:	i) Damage to left winglet ii) Damage to right wing tip
Commander's Licence:	i) N/K ii) Air Transport Pilot's Licence
Commander's Age:	i) N/K ii) 47 years
Commander's Flying Experience:	i) N/K ii) 20,000 hours (of which 806 were on type) Last 90 days - 230 hours Last 28 days - 60 hours
Information Source:	AAIB Field Investigation

Synopsis

The holding area for Runway 27L at London Heathrow Airport is wide enough for two 'heavy' aircraft to position side by side and aircraft entering this area essentially follow a single yellow taxiway centreline, which then splits into two parallel lines. Prior to departure, an Airbus A340 was stationary, well short of the N2W traffic bar behind an Airbus A320, which was stopped at the NB2W

traffic bar, in the holding area awaiting its turn to line up. It was positioned on the southern most line, on the right of the holding area. Whilst in that position, a Boeing 777 was instructed to taxi forward and hold on the left of the holding area. As it passed behind the A340, the handling pilot made use of reference points within the cockpit to assure wingtip clearance from the A340's tail

but, as he continued along the northern taxiway line, the right wingtip of the B777 made contact with the left winglet of the A340. At the point of contact, the B777 had not reached the section of the line parallel to that upon which the A340 was parked. Although the B777 flight crew thought that the A340 was closer than it might be at other airports, this was not considered unusual for Heathrow. Four recommendations are made addressing issues arising from the preservation of Cockpit Voice Recorder data.

History of the flight

In daylight with fine weather and good visibility, an Airbus A340 (A340) was cleared to taxi from Stand 314 at Terminal Three, via taxiway B and Link 29, to holding point LOKKI, in preparation for a departure from Runway 27L¹. A Boeing 777 (B777) which had pushed back from

Stand 321, which is also at Terminal Three, had been cleared by the Ground Movement Controller (GMC) to follow the A340, again for a departure from Runway 27L. See Figure 1.

While taxiing, the crews in both aircraft were instructed to monitor the Heathrow ATC 'Tower' frequency.

Having held at LOKKI, the A340 was instructed by the Air Departures Controller (ADC), on the Tower frequency, "TO LINE-UP AND WAIT RUNWAY 27L" after an Airbus A310 (A310), which was holding at N2E on the left side of the holding area, had departed. The A340 taxied forward and held on the right of the holding area behind an Airbus A320 (A320), which was stopped at the NB2W traffic bar. The A310 had been cleared to line up on the runway after the A320 had departed. The A340 stopped well short of the N2W traffic bar, astern of the A320. The B777 was then instructed to "TAXI FORWARD, HOLD ON THE LEFT". A Boeing 747 (B747), which was approaching along Taxiway U on the B777's left, was instructed to give way to the B777

¹ For the locations of the various taxiways and holding area and traffic bars at London Heathrow Airport (LHR) referred to in the following narrative, see Figures 1 and 2.



Figure 1
Taxi Chart

and also to hold on the left of the holding area. As the B777 taxied forward its crew were given their line-up clearance and were advised that they were number six in the departure sequence.

The B777 taxied behind the A340 towards the left side of the holding area. As it did so the commander, who was the handling pilot, made use of reference points on the flight deck of his aircraft, as advised in his company's operations manual, to ensure clearance between his right wing tip and the tail of the A340². Although the crew thought that the A340 was closer than it might be at other airports, the co-pilot stated that this was not unusual for LHR, which has less space than other airports³.

Having cleared the A340's tail, the B777 followed the taxiway centreline round to the right, leading to the left side of the holding area, so as to draw up on the left of the A340. During this turn the B777's right wing tip made contact with the A340's left winglet. The commander of the A340 advised ATC that he believed that his aircraft had been struck. He had felt a jolt and his cabin crew subsequently told their commander that they thought that the aircraft had been struck on the tail by the B777. Upon enquiry the crew of the B777 advised ATC that they had not noticed the contact. A ground vehicle was dispatched to check for signs of damage. Airport staff reported damage to the left winglet on the A340 and the right wing tip on the B777. Also some debris was found on the ground below the respective wingtips. The A340 and B777's line-up clearances were cancelled and both aircraft were advised to taxi back on to a stand to enable engineers to inspect the damage. The holding area was closed to allow the debris to be cleared up.

² Flight crew on a B777 are unable to see their aircraft's wing tips from the flight deck so the operator had identified reference points on the flight deck windows which could be used by the crew to gauge whether an external obstacle fell outside the path to be followed by the aircraft's wing tips.

³ London Heathrow Airport operates within a site of restricted size and it is apparent that the airport is often working to capacity.

Engineering examination

Examination of the aircraft involved showed that the A340 had suffered an impact into the trailing edge of its left winglet at a position approximately 30% (winglet) span, causing localised deformation of the trailing edge skins. The right wing tip fairing of the B777 exhibited bruising and paint smearing which extended rearwards from the leading edge back to the trailing edge, fracture of the navigation light lens and damage to other light fittings and lenses mounted on the fairing. Taken together, the pattern of damage was consistent with the right wing tip of the B777 having struck the left winglet of the A340 from behind, as the former was passing the latter. The extent of overlap between the two aircraft was minimal, of the order of 300 mm, and damage to both aircraft was confined to their removable wing-tips. The Minimum Equipment List (MEL) for each aircraft permits flight with one or both winglets or wing tip fairings removed.

It was confirmed that the B777's wing-tip was not visible from the cockpit.

Although the taxiway was cleared of debris by a mechanical sweeper before any record of its position could be made, a careful examination of the taxiway surface revealed some coloured glass shards consistent with the fractured lens on the B777's right wing tip. Although the precise position of the collision could not be determined from this debris, due to potential disturbance by the sweeping machine, it was considered unlikely that these items would have been displaced significantly from their original post-collision positions. Accordingly, the boundary of the region containing these items was noted for inclusion in a later analysis of aircraft and taxiway geometry, Figure 2.

Recorded data sources

The A340 aircraft was released for operation without the Cockpit Voice Recorder (CVR) or Flight Data Recorder (FDR) being removed or interrogated but the CVR and FDR were retrieved from the B777 and downloaded by the AAIB. The 30 minute duration CVR had overrun

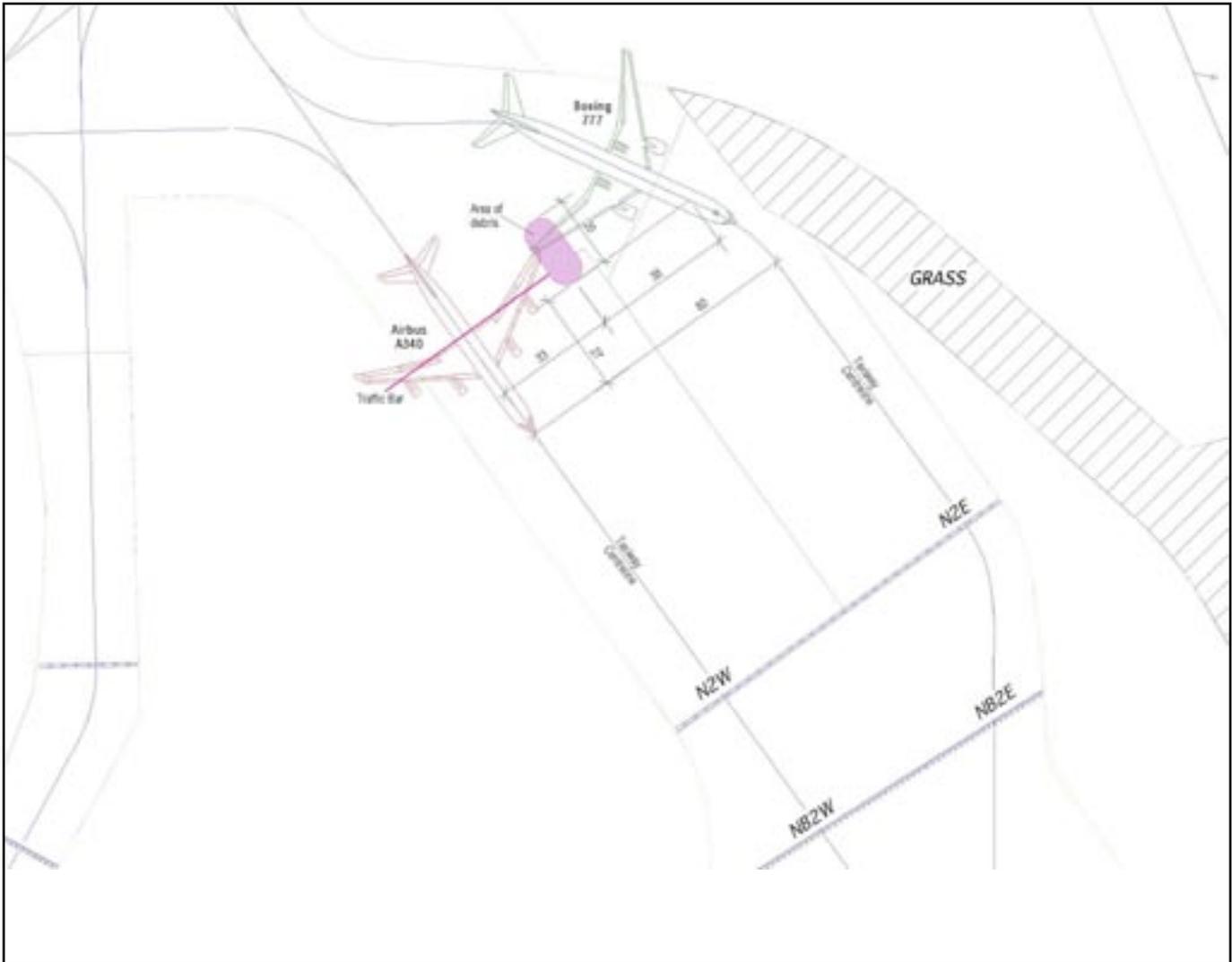


Figure 2
Aircraft positions at Runway 27L Holding Area
(measurements in metres)

before power was isolated but the FDR yielded useful information. ATC radio transmissions and the ground radar display at the time of the incident were also recorded and used during the investigation. At LHR, the ground radar is recorded, and this showed all ground movements of the aircraft with a radar signature overlaid with a marker derived from the 'multilateration' system. This system triangulates the location of the aircraft from the ATC transponder transmissions.

VHF keying was also recorded and enabled correlation with the CVR and ATC recordings to be made.

B777 CVR

The CVR was a 30 minute solid state unit manufactured by Honeywell. The unit was left running for more than 30 minutes after the incident and so information relating to the incident had been overwritten. Unusually, the circuit breaker for the CVR on the B777 is located in the electronics bay under the floor and this area is accessed via a hatch near the front left door. There is no apparent method for the crew to stop the CVR recording, and hence overwriting relevant data, from within the cockpit. A problem was identified with the cockpit area microphone

channel recording, in that it had only recorded a large amplitude 400 Hz signal. The operator was informed of this defect and undertook to rectify the problem.

The operator's crew procedures, regarding the CVR after an incident, are contained in the Flight Operations Manual, VOL 1, POLICIES AND PROCEDURES under section 'Operating Information Enroute Procedures', pages 8.40.8 and 8.40.9, dated 21 May 04. Extracts from manual this are shown below:

'If an incident that requires immediate notification of the NTSB occurs within the last 30 minutes before landing, contact the FODM as soon as possible for instructions on how to remove power from the cockpit voice recorder. Reportable incidents include the following:

- *Flight control system malfunction or failure*
- *Fire*
- *Substantial damage to airplane (engine failures, tires, dents are not considered substantial)*
- *Fatal or serious injury to any person'*

And

'Authorization to remove a specific tape may be given only by the Senior Vice President - Flight Operations, the Managing Director - Flight Standards and Training, Managing Director - Domicile Operations and System Chief Pilot, or the Vice President - Safety, Security, and Quality Assurance.'

B777 FDR data

The data confirmed that the B777, which was crossing behind the stationary A340, was turning to take up a heading parallel to the A340 on its right. At the time the B777's right wingtip struck the rear of the A340's left wingtip, it was travelling at approximately 7 kt, and turning right, resulting in a wingtip speed of approximately 2.7 kt. The wingtip impact generated a lateral acceleration (g) of 0.05g to the left and, after the B777's wingtip rubbed along the A340 wingtip for approximately 1.5 seconds, a spike

of 0.04g to the right. At this point the aircraft's speed was recorded as 6 kt and its magnetic heading samples either side of the initial impact g spike were recorded as 115°M and 118.5°M.

Recorded data analysis

The different sources of recorded data all used separate timebases. However, matching the FDR recorded VHF keying with the ATC radio transmissions, along with NATS records of the differences between the ATC audio and ground radar time bases, allowed the different sources to be correlated. Figure 3 shows the main parameters from the FDR. The collision occurred at 12:53:51 hrs and three ground radar plots covering this time, each separated by 1 second, are presented in Figures 4 to 6.

ATC Procedures

The Manual of Air Traffic Services (MATS) Part 1 states that:

'the movements of aircraft....on the manoeuvring area.... are subject to permission from aerodrome control'.

The ATC Air Departures Controller (ADC) stated that, to maximise runway usage, Heathrow ATC aim to depart Heavy and Medium (weight) aircraft in alternating blocks of approximately six of each type. To facilitate this and avoid congestion on the taxiways, he was attempting to fill the Runway 27L holding area. MATS Part 2, which includes taxiing procedures for LHR, stipulates that, for the Runway 27L Holding Area;

'One heavy is permitted to hold at N2E and to be passed by Heavy and other aircraft taxiing to N2W'.

While being aware of this, the ADC understood that if there was one Heavy aircraft on the left side of the holding area, at holding point N2E, and another Heavy aircraft on the right side at N2W, a further Heavy aircraft could join on the left. In understanding that, he had

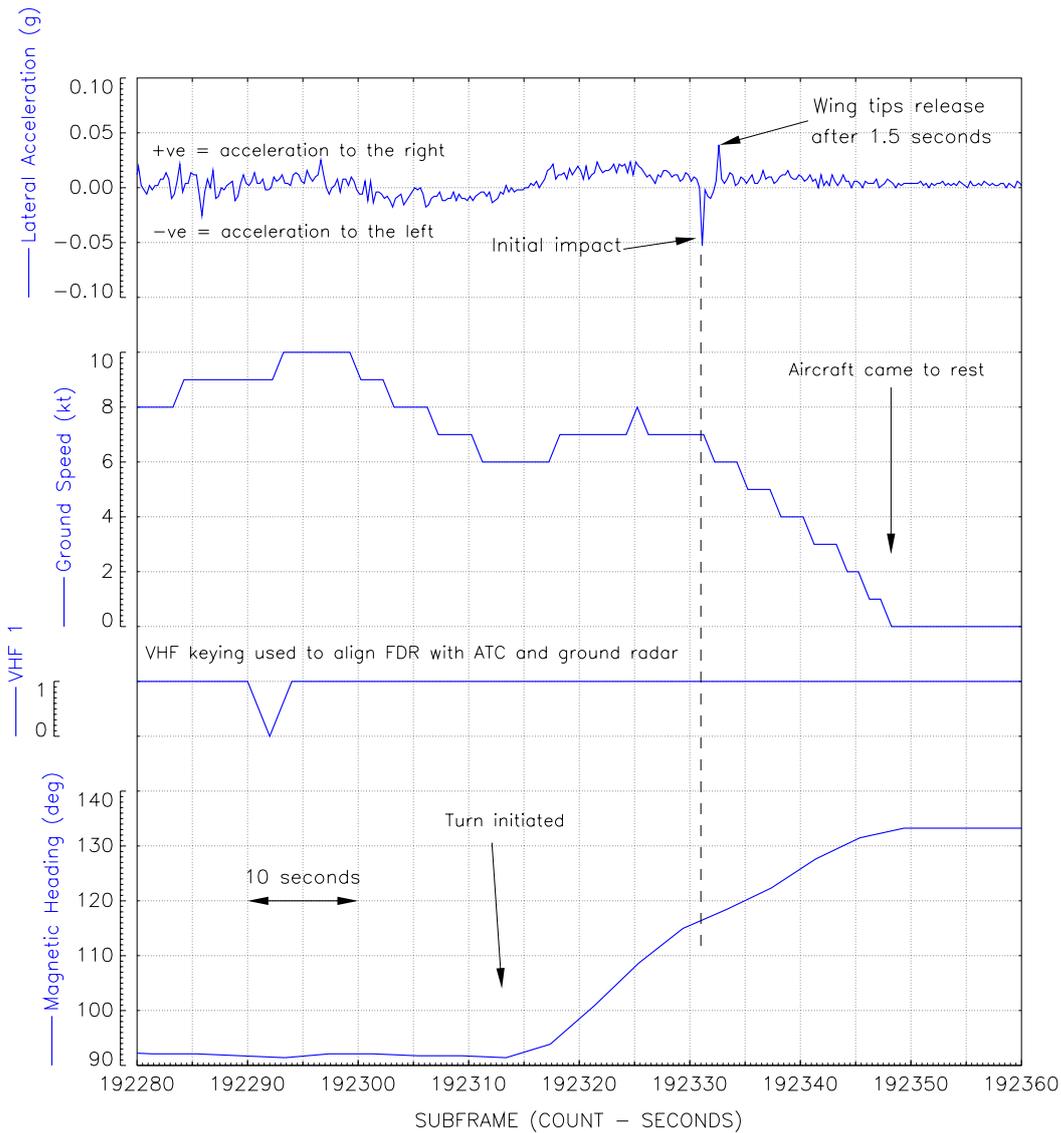


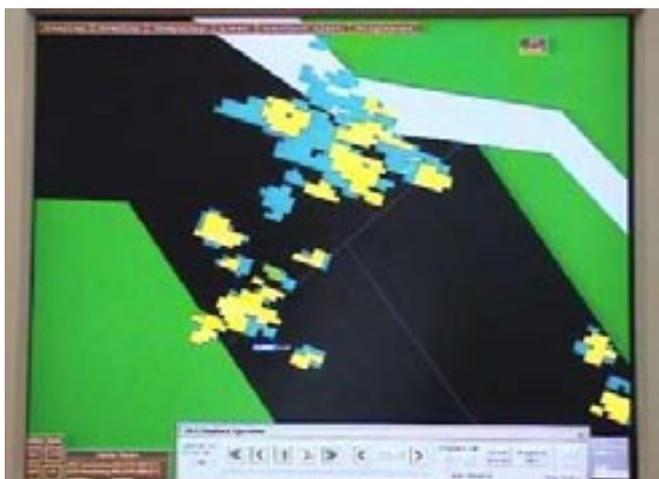
Figure 3
 Key FDR parameters from the B777.
 Accident to N781UA / 6Y-JMP on 14 July 2004 at Heathrow

expected the A340 to stop further forward on the right, at N2W, thus giving room for the B777 to taxi to the left side of the holding area. However, the A340 could not do this until the A320 ahead of it had lined up on the runway. The ADC mentioned that, although it was a clear day, it was difficult to see precisely where the aircraft had stopped from his controlling position in the Visual Control Room (VCR) atop the tower.

Civil Aviation Publication (CAP) 637, entitled ‘Visual Aids Handbook’, explains in general terms the purpose

and significance of the visual aids currently employed at licensed aerodromes in the United Kingdom (UK), as notified in the appropriate aerodrome entry in the UK Aeronautical Information Publication (AIP). It states:

*‘Taxiway centrelines are located so as to provide safe clearance between the largest aircraft that the taxiway is designed to accommodate and fixed objects such as buildings, aircraft stands etc., provided that the pilot of the taxiing aircraft keeps the **‘Cockpit’** of the aircraft on the centreline and*

**Figure 4**

Ground radar - 12:53:50 UTC - video time reference

**Figure 5**

Ground radar - 12:53:51 UTC - video time reference

**Figure 6**

Ground radar - 12:53:52 UTC - video time reference

*that aircraft on a stand are properly parked. Taxi Holding Positions are normally located so as to ensure clearance between an aircraft holding and any aircraft passing in **front** of the holding aircraft, provided that the holding aircraft is properly positioned **behind** the holding position. Clearance to the rear of any holding aircraft cannot be guaranteed. When following a taxiway route, pilots are expected to keep a good lookout and are responsible for taking all possible measures to avoid collisions with other aircraft and vehicles’.*

The LHR entry in the Aerodrome section of the UK AIP includes a section on Local Traffic Regulations. Under the title ‘Ground Movement’ it gives general instructions which include the following:

‘Runway Holding Areas for aircraft departing on Runways 27L... At all times in good visibility an ATIS [Automatic Terminal Information Service] message will remind pilots that they remain responsible for wing tip clearance.’

The LHR ATIS message, transmitted at all times except during Low Visibility Procedures (LVPs), states:

“Pilots are to exercise caution when manoeuvring in the Runway Holding Areas as wing tip clearance is not assured”.

Following this incident, London Heathrow MATS Part 2 was amended to reflect the removal of runway traffic bars NB2E and NB2W in a bid to reduce the risk of wing tip collision in the Runway 27L holding area. This means that the CAT I/II and III Runway Guard Bars are now co-located at the N2E and N2W traffic bars.

Actions following previous accidents/incidents

Following a very similar accident at the same place on the airport in 1997 (AAIB Bulletin 9/97), Heathrow Airport Limited, the airport authority, undertook to set up a working party to, (a), examine the current daylight (non Low Visibility Procedure) procedures for runway holding areas, (b), examine whether or not pilots should be given additional guidance within runway holding areas and (c), review the British Airports Authority (BAA) design standards for runway holding areas.

It was not possible to find a record of the working party's conclusions.

Analysis

This serious incident stemmed from a desire by ATC to maximise the number of aircraft at the holding area for Runway 27L, which was a consequence of the need to prevent congestion on the taxiway. The perception in the minds of the B777 flight crew was that it was not unusual at LHR to see another aircraft as close as the A340 appeared to be and their belief that, having cleared the tail of the A340, they would avoid other obstructions if they followed the taxiway centreline.

The B777 had received permission to taxi on beyond the LOKKI holding point but, as stated in the various UK

publications, the crew was expected to take all possible measures to avoid collisions with other aircraft. Their vantage point in judging clearances from other aircraft, obstructions, etc, was far better than that of the ADC, although the crew were constrained by being unable to see the wingtips of their own aircraft. It is likely that, having reference points within the flight deck to ensure wingtip clearance from external obstacles, increased the crew's confidence in their ability to manoeuvre in a confined space. This, in turn, may have encouraged them to comply with the clearance to taxi forward and hold on the left without delay, although it would also be natural for a pilot to comply with ADC instructions sooner rather than later. However, being number six in the departure sequence, there was no urgency for their aircraft to taxi on to the left side of the holding area until the A340 had moved further forward. That was what was envisaged by the ADC and this arrangement would not have contravened the instructions in MATS, Part 2, relating to the holding area for Runway 27L. In this case, the damage to each aircraft was minimal and the A340 resumed its schedule after a short delay. The removal of the NB2E and NB2W holding points addresses the possibility of wing tip collisions as the Holding Area narrows at its southern end. Bearing in mind the particular constraints at LHR, the ATIS message concerning wing tip clearance is designed as a reminder for crews facing this sort of situation.

Safety Recommendations

The CVR fitted to the B777 aircraft had a recording period of 30 minutes. The crew were required by their company procedures to contact another person for information on how to isolate power to the CVR. It is fair to assume that the shortest reasonable time between such an incident occurring and the actual isolation of power to the CVR, would mean that most if not all of the 30 minutes of recorded data would have been overwritten. The crew procedures also do not adequately identify the scope of serious incidents that require the preservation of the CVR information. The combination of limited CVR recording time and crew procedures does not adequately address

the need for preservation of data in the event of an incident or accident. The FAA have recently published a NPRM declaring the intent for CVRs which are fitted to have a minimum duration of 2 hours, but this will only apply to aircraft within their jurisdiction. In order to maximise the probability that pertinent CVR information will be available, after a serious incident or accident, the following Safety Recommendations are made:

Safety Recommendation 2005-051

It is recommended that the Joint Aviation Authorities, in common with the Federal Aviation Administration intent, mandate a minimum recording duration of two hours for all aircraft currently required to be fitted with a Cockpit Voice Recorder.

Safety Recommendation 2005-052

It is recommended that the Federal Aviation Administration and the Joint Aviation Authorities review their processes of oversight of Operator's procedures and training support to ensure the timely preservation of Cockpit Voice Recorder recordings in accordance with ICAO Annex 6 Part I, 11.6, following a serious incident or accident. The operator procedures and training should provide the necessary skills and information to identify accidents and serious incidents and implement the necessary tasks to preserve these recordings in a timely manner.

Safety Recommendation 2005-053

It is recommended that the Federal Aviation Administration require United Airlines, and any other airline regulated by the Federal Aviation Administration with similar procedures, to amend their procedures to ensure prompt identification of accidents and serious incidents and timely preservation of Cockpit Voice Recorder recordings.

before a 'specific tape' from a CVR can be 'removed', is contrary to the requirements of ICAO Annex 13 to the Convention on International Civil Aviation, paragraph 5.6, and has no legal standing when an incident such as this occurs within the UK⁴.

On this occasion, the loss of CVR data did not impede the AAIB investigation. However, in different circumstances it might, and there would be significant implications for the Operator's flight crew who would find themselves in a position whereby they must choose to either contravene their Company policy or fail to comply with the legal requirements of a national Investigative Authority and the obligations of ICAO Annex 13. The following recommendation is therefore made.

Safety Recommendation 2005-054

It is recommended that the Federal Aviation Administration require United Airlines to amend their relevant procedures so as to ensure that flight and ground crews are made fully aware of their obligation following an accident or serious incident to allow unhampered access by the appropriate national Air Accident Investigation authorities to the flight recorders by complying with the requirements of ICAO Annex 13, paragraph 5.6, and associated national legal requirements.

The United Airlines requirement for their flight crews to gain authorisation from senior company employees

⁴ An equivalent situation exists with regard to the powers of the NTSB should a notifiable event, such as this, have occurred within the USA to a UK registered aircraft.