Boeing 737-236, G-BKYI

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Aircraft Type and Registration:	Boeing 737-236, G-BKYI
No & Type of Engines:	2 Pratt & Whitney JT8D-15A turbofan engines
Year of Manufacture:	1984
Date & Time (UTC):	8 November 1996 at 0820 hrs
Location:	Approach to Runway 27L
	London Heathrow Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 6 - Passengers - 82
Injuries:	Crew - None - Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	Approximately 12,000 hours (of which 5,000 were on type)
	Last 90 days - 110 hours
	Last 28 days - 50 hours
Information Source:	AAIB Field Investigation

History of the flight

The aircraft was inbound to London Heathrow on a scheduled flightfrom Jersey. While fully established on the approach for Runway27L, the aircraft encountered two separate uncommanded roll events. The first was with flap 5° selected, followed by a morepronounced event almost coincident with the flap 25° selection. In both cases the aircraft rolled in a gentle but positive manner. The crew considered that the roll force was very smooth and quitestrong, with no detected rudder or yaw damper movement. The crewcommented that the rolling motion was not characteristic of anypreviously experienced wake vortex encounters.

The commander, who was the handling pilot, initiated a go-aroundand transmitted a PAN call to ATC advising of a flight controlproblem. The possibility of a flap asymmetry was considered,but there was no indication of such an asymmetry on the flap indicator. A handling check was performed by decelerating the aircraft toan approach/manoeuvring speed of 150 kt with 15° flap. Noabnormalities were noted by the crew, so radar vectoring was acceptedfor a left hand pattern to reposition for a further ILS approachwhilst maintaining the established 15° flap landing configuration. The autopilot was engaged after the go-around and maintaineduntil about 700 feet on final approach, followed by an uneventfulmanual landing by the First Officer.

The London Heathrow METAR for 0820 hrs gave the surface wind as170°/2 kt, visibility 18 km, few/scattered cloud base 6,000feet. The temperature was +3.6°C and dew point +1.5°C,the QNH was 1023 mb.

Engineering Investigation

The aircraft was withdrawn from service and subjected to a detailedprogramme of checks carried out by the operators' maintenancepersonnel in conjunction with the manufacturer and AAIB. Themanufacturer initially drew attention to the possibility of thelost motion clutch system of the inboard flap drive (intendedto break out if a new flap setting is selected with the flap slot/tracksobstructed) having permitted asymmetric inboard flap deploymentto occur. No evidence was found to suggest that this had occurredand it was noted that the flap deployment sequence (ie the relationshipbetween linear and angular movement) made it unlikely that asymmetryof the inboard flaps, occurring at the stage in the deploymentsequence coincident with the uncommanded roll events, could producea major rolling moment.

The operators' engineering department required the following listof work to be carried out on the aircraft:

Inboard trailing edge flap adjustment/test.

Outboard trailing edge flap adjustment/test.

Spoiler adjustment/test.

Aileron trim control adjustment /test.

Replacement of rudder PCU.

Cycle of yaw damper switch and observation of rudder for signsof deflection.

Inspection and leak check of forward toilet system.

Investigation of water leak from FWD galley (found on initialinspections).

Replacement and bench testing of aileron clutch mechanisms.

Inspection of inboard mid-flap for correct rigging.

Check of flap fairing with flaps up.

Check of aileron rigging and tensions.

Hydraulic fluid sample analysis.

The only discrepancies found on completion of these checks were:

(i) Water leak located in forward galley area.

(ii) Flap clutch mechanisms failed bench break-out test.

(iii) Water leak into junction box 5 found.

(iv) Yaw damper coupler failed BITE test 7 (coupler replaced).

The break-out forces of both flap clutch mechanisms were onlyslightly below specification and comparable to some other unitswhich had seen a similar period of service. Junction box 5 containswiring associated with stabilator trim control function; defectsin this area will not, in isolation, influence roll or yaw behaviour.

The aircraft was subsequently test-flown without any significantdefect being noted. It was returned to service and thereafterrevealed no evidence of any associated defect.

Flight Data Recorder Information

The Quick Access Recorder (QAR) was replayed by the operator;the data showed that at 2,700 feet, 182 kt on approach theaircraft rolled 8° left wing down at a rate of about 5°/sec. This was opposed by the pilot with almost 40° control wheelinput, before the aircraft returned to wings level. Ten secondsafter the uncommanded roll the flap was selected and moved from5° to 10° and the aircraft continued the approach. At 1,400 feet, 155 kt, with flap 20° and landing gear down,the aircraft underwent two roll reversals, initially to 10°left and then 10° right, with a maximum roll rate of about6°/sec. This occurred 3 seconds before flap 25° wasselected. The roll reversals were opposed by opposite controlwheel inputs. The engine power was then increased as the go-aroundwas initiated, flap 10° was selected and the minimum altitudewas 1,000 feet before the aircraft began to climb away. The subsequentapproach was normal.

In response to the incident, after analysis and considerationof the circumstances, the manufacturer stated that:

'The first event has the characteristics of a typical wake vortexturbulence encounter with perturbations in airspeed and normalacceleration which are inconsistent with pitch attitude and thrust. The second event shows airspeed perturbations, however, the smallchanges in normal load factor are consistent with changes in pitchattitude. In addition to the airspeed changes, the perturbationsin lateral acceleration and the character of the roll suggestthat the event was also an external disturbance. Similar perturbationsin lateral acceleration occur during wake turbulence encounterswhen the vortex core impinges on the vertical tail... The FDRdata showed that for both the events the aircraft started rollingbefore significant heading changes occurred. The absence of headingchanges during the start of the events indicates that the rolldid not result from sideslip (e.g. sideslip due to rudder deflection).'

Wake Vortex Consideration

In order to establish the possibility of a wake vortex encounter,the sequence and spacing of several preceding aircraft was determinedfrom radar information. The approach sequence studied was a Boeing747, Boeing 767, Boeing 737400, DHC Dash Eight followedby 'YI, the incident aircraft.

Figure 1 shows the approach path of the incident aircraft andthe DHC Dash Eight. The first uncommanded roll event occurredat 8.1 nm from touchdown, when 'YI was 2.9 nm behind the DashEight (60 seconds elapsed time). The second uncommanded rollevent occurred at 4.5 nm from touchdown when 'YI was 2.8 nm behindthe Dash Eight (56 seconds elapsed time).

The Dash Eight wake would have been affected by the tendency ofits wake to descend and also by wind drift. Wake vortex studiessuggest that the vortices tend to drift slowly downwards at arate of approximately 400 feet per minute. This aspect was detailedin AAIB Bulletin 2/97 Reference EW/C96/9/3.

In Figure 1, the position of the wake is therefore representedby a band, and the figure shows that the path of 'YI was coincidentwith the estimated location of the wake at around the altitudeof the recorded uncommanded roll events.

Reduced Final Approach Spacing Trial at Heathrow Airport

A trial is in progress at London's Heathrow and Gatwick Airportsto reduce the final approach spacing of aircraft to a minimumof 2.5 nm, provided that certain criteria are met. Details ofthese criteria were published by the CAA in a Yellow AeronauticalInformation Circular (AIC) 94/1997 (Yellow 264) published on 15July 1997. Phase 2 (the current phase) of this trial commencedin January 1996.

The salient features of the trial are that both aircraft shouldbe within 15 nm and greater than 4 nm from touchdown, establishedon an ILS Localiser (or on a closing heading to it) and that noWake Vortex Spacing minima is detailed in the Wake Vortex Tableaccompanying the AIC. In this case, the Dash Eight was categorisedas a 'Small' and the B737 as a 'Lower Medium' for Wake Vortexseparation purposes (Note: the MATS Part 1 Inbound Wake Vortexrequirements are modified at Heathrow by splitting the Wake VortexGroup categorisation of 'Medium' into 'Upper Medium' and 'LowerMedium', based upon Maximum Allowable Take-off Weight.). Forthe Reduced Final Approach Spacing Trial, the AIC indicates thatWake Vortex separation is not required, thus allowing reducedseparation to 2.5 nm until 4 nm from touchdown. In the Manualof Air Traffic Services Part 1, the required spacing between successiveaircraft on final approach for these groups is 3 nm minimum.

The upper winds recorded by the preceding Boeing 737-400 aircrafton approach were:

2,500 feet 252°T/6 kt
2,000 feet 278°T/4 kt
1,500 feet 280°T/6 kt
1,000 feet 251°T/6 kt
Touchdown 157°T/4 kt

An objective of the Reduced Separation Trial is to maintain ahigh landing rate in conditions of strong headwinds so that tacticalcapacity is not adversely affected. The minimum recommended

headwindcomponent stated in the trial conditions was 10 kt. On this occasion,therefore, the trial was not in operation and the minimum radarseparation requirement should have been 3 nm.