Boeing 737-3YO, G-BWJA, 19 May 1997

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Aircraft Type and Registration:	Boeing 737-3YO, G-BWJA
No & Type of Engines:	2 CFM56-3B2 turbofan engines
Year of Manufacture:	1989
Date & Time (UTC):	19 May 1997 at 1355 hrs
Location:	London Luton Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 5 - Passengers - 51
Injuries:	Crew - None - Passengers - None
Nature of Damage:	Rear water drain mast damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	8,346 hours (of which 2,842 were on type)
	Last 90 days - 200 hours
	Last 28 days - 82 hours
Information Source:	AAIB Field Investigation

History of flight

The first officer was undergoing his first week of line trainingand had already completed 10 sectors, all under the supervisionof the same Training Captain who was the commander on the incidentflight; following satisfactory progress, the 'screen' first officerhad been released after 8 sectors. The commander had assessedthe previous 7 take offs, carried out by the first officer, assatisfactory. This flight was the first of the day for the crew. The weather was reasonable with light rain and a surface windof 180°/08 kt; Runway 08 was in use.

Flap 1 was used for take off and the passengers were distributedevenly throughout the cabin. The ground roll was normal and thefirst officer commenced rotation at the commander's call of

"Rotate";this had been calculated as 126 kt and was coincident with V1. The commander assessed that the aircraft nose pitched up morerapidly than normal but not excessively so and he considered itas a result of the light take-off weight. Subsequently, the climbwas normal and the handling pilot levelled the aircraft at cruiseflight level. However, one of the cabin attendants who had beenseated at the rear of the aircraft had noted an unusual noiseat take off and, during the cruise, reported the fact to the commander. There had been no comment from ATC at Luton and a check of thecockpit indications revealed no adverse indications; the pressurisationhad performed normally during the climb and level off. Therefore,the commander decided to continue the flight to Edinburgh andthe first officer made a normal landing at 1442 hrs.

After arrival on the stand, the commander checked the rear ofthe aircraft and noted that the water drain mast had scrape marks. He postulated that this had occurred on take off from Luton andinformed the aircraft ground engineers. Checks of the airframeconfirmed the scrape marks on the drain mast but no other damage.

Flight Data Recorder

The Flight Data Recorder (FDR) was removed from the aircraft andreplayed. The Cockpit Voice Recorder (CVR) was not removed asthe incident had been recorded over.

The FDR data showed that the aircraft had commenced take off at1355 hrs on a heading of 083°M with Flap 1 selected. Throughoutthe take-off roll, left rudder of between 2° and 4°was maintained. The elevator surface positions remained at approximately3° trailing edge down until a speed of 125 kt was reached. Then, over the next one and a half seconds, the elevator surfaceswere raised to between 9° and 11° trailing edge up. This position was held for the next two seconds during whichthe pitch attitude increased from 1.4° to 12.8° noseup; a peak rate of change of pitch of 9° per second was recorded. During this time, the air/ground sensor indicated main gearoleo extension, the aircraft started a slight roll to the leftand the airspeed increased to 137 kt. In the next second, a peakaircraft pitch attitude of 16° nose up was recorded. Theleft roll reached a maximum of 3.9°, before the aircraftreturned to wings level.

The aircraft pitch then reduced to between 13.5° and 14°as the aircraft accelerated through an airspeed of 143 kt. Itsubsequently climbed away at approximately 160 kt with a pitchattitude between 16° and 18°. No unusual readings wererecorded on the vertical acceleration during the take off.

Aircraft Information

Boeing Commercial Airplane Group recommend that the Boeing 737is rotated smoothly with one continuous motion at a rate of nomore than approximately 3° per second up to target pitchattitude. Aft fuselage contact with the runway is possible iftake-off attitudes higher than normal are reached before lift-off. The usual causes for aft fuselage contact with the runway areearly rotation (prior to VR) and/ or a rapid rotation rate inexcess of 3° per second. Flap position also affects aftfuselage to runway clearance during take off. For the Boeing737-300, Flap 1 yields the least clearance and Boeing suggestin the Flight Crew training Manual that the use of Flap 5 be consideredfor take off at light gross weights; however, no definition of'light gross weight' is given. With a normal rotation rate, theall-engine lift-off attitude is 9 to 10°.

Boeing were also asked for information on the pitch angles requiredfor body contact. They provided the following information:

"Due to the close proximity of the drain mast to the airplanecentreline, the drain mast will contact prior to the body of theaircraft with zero roll angle. In other words, the minimum rollangle necessary to produce damage to the drain mast is zero degrees.

For an extended oleo (13 inch stroke) with the airplane stillon the ground, a pitch angle of 12.8 degrees is required to causedamage to the drain mast. At this pitch angle, there will bea 3.5 inch clearance between the ground and the aft body. A pitchangle of 13.4 degrees is required to contact the aft body.

For a static oleo (not fully compressed) with the airplane stillon the ground, a pitch angle of 10.6 degrees is required to causedamage to the drain mast. At this pitch angle, there will bea 1.5 inch clearance between the ground and the aft body. A pitchangle of 10.8 degrees is required to contact the aft body.

Our experience indicates that most 737 tail strikes during takeoff occur with an extended oleo."

Company comments

The commander subsequently commented that the company "FreeSeating" policy sometimes leads to minor trim differencesbetween that indicated on the load sheet and what is actuallyrequired. At the time of the incident, the purser was only requiredto indicate to the commander if the passengers were not evenlyspread throughout the cabin. Generally, from the commander'sprevious experience with this airline, passengers will fill theseats from the front but, on this occasion, they were evenly spreadand therefore the control wheel force required may have been lessthan the first officer had previously experienced. Immediatelyafter this incident, the company instituted a requirement forthe purser to advise the commander of the exact seating on everyflight.

The company policy is to use optimum flap performance and thereforethe crew are presented with only one page of performance datafor each runway end; on this occasion, the flap setting presentedto the crew was Flap 1.

Summary

The aircraft take-off speeds were calculated correctly and rotationwas initiated at VR. The rotation reached a peak of 9° persecond but fortunately the pitch attitude prior to lift-off didnot exceed 13°; the maximum pitch attitude of approximately16° occurred shortly after lift-off. Damage to the drainmast occurred as a result of the pitch attitude reaching 12.8°with an extended oleo and the aircraft still on the ground. Thispitch attitude followed from an excessive rotation rate of 9°per second.

At the time of the incident, the company policy of 'Free Seating'meant that the calculated take-off trim could have been inaccurate. For an inexperienced pilot, the tendency is to increase the rotationrate as confidence increases; an inaccurate trim position anda light aircraft would accentuate this tendency.

After this incident, the company introduced a positive seat checkprior to each departure.