McDonnell Douglas DC 10-30, PP-VMD

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Aircraft Type and Registration:	McDonnell Douglas DC 10-30, PP-VMD
No & Type of Engines:	3 CF6 turbofan engines
Year of Manufacture:	1975
Date & Time (UTC):	8 February 1997 at 2227 hrs
Location:	London Heathrow Airport
Type of Flight:	Scheduled Passenger
Persons on Board:	Crew - 18 - Passengers - 127
Injuries:	Crew - None - Passengers - None
Nature of Damage:	No 7 and 8 wheels and tyres badly damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	50 years (approximately)
Commander's Flying Experience:	14,000 hours (of which 4,500 were on type)
	Last 90 days - 60 hours
	Last 28 days - 20 hours
Information Source:	AAIB Field Investigation

History of Flight

The aircraft involved in this accident arrived at London HeathrowAirport from Rio de Janeiro earlier the same day at 1233 hrs. On arrival it was parked at Gate H30 and later towed to its departureGate H5 at 1945 hrs. At 2207 hrs the flight was cleared for enginestart and push-back and it commenced taxiing to Runway 27R nineminutes later. The taxi route to the runway took the aircraftdirectly onto the outer taxiway and then onto Runway 23 whichit backtracked. The total time spent taxiing was approximatelynine minutes.

The flight destination was São Paulo, Brazil and, due tothe length of the flight, two flight deck crews were on board. The crew had arrived two days previously and, for the departure,consisted of a Captain in the left hand seat, who was undertakinga conversion from a different aircraft type, and a training Captainin the right hand seat who was the designated aircraft commander. The Captain under training was the handling pilot.

The weather at the time of the take off comprised a wind of 220_/4kt, visibility 6 km in mist, temperature 5_C and dew point 4_Cwith a QNH of 1028 mb: the sky was clear. On arrival at the holdingpoint for Runway 27R, the flight was cleared by ATC to line upafter the departure of a previous aircraft which was already onthe runway. At 2225 hrs the flight was cleared for take off.

The aircraft was at its maximum certificated weight of 256,000kgs for take off and maximum thrust was used with a 15_ flap setting. No 3 engine thrust reverser was locked out for this flight fortechnical reasons and this was permitted under the terms of theMinimum Equipment List for the type. The autobrake was selectedto the rejected take off mode (RTO). V_1 hadbeen calculated as 164 kt.

Initial acceleration for take off was normal until a speed ofapproximately 130 kt was reached when a loud bang was heard bothby the crew members and by ATC. The aircraft then tilted to theright and yawed slightly. Suspecting a tyre failure the commanderinstructed the other Captain to abandon the take off, which hedid as the speed reached approximately 135 kt to 140 kt. Thepilot had no difficulty in keeping the aircraft straight and,as there was considered to be adequate runway length remaining,the autobrake system was cancelled at about 100 kt. During thistime the commander advised the tower of the RTO and was instructedto remain on the runway until the fire service had carried outits inspection. The aircraft was brought to a standstill on thecentreline of the runway just beyond the displaced threshold ofRunway 09L with approximately 300 metres of runway remaining.

There was no fire and the passengers were able to remain on boardthe aircraft until airsteps arrived for their disembarkation.

Flight Data Recorder Information

The Flight Data Recorder, a Sundstrand DFDR, was removed and replayedby the AAIB; some of the data, including that covering the incident,was corrupted. The maximum airspeed recorded was about 140 kt. Of the 87 parameters recorded there was none which related toeither the brake system or the tyres. The flight recorder wasreturned to the operator for investigation of the fault whichcaused corruption of some of the data.

Engineering examination

AAIB Inspectors were able to examine the damage to the aircraftwhile it was still in its position at the end of Runway 27R. The principal damage was to the tyres and wheels at the Nos 7and 8 position: on the DC-10 type the wheels are numbered fromleft to right across the front and then the rear of the two mainlanding gears; thus wheels 7 and 8 are, respectively, the inboardand outboard rear wheels of the right-hand main landing gear,with wheels 3 and 4 immediately ahead. On both wheel Nos 7 and8 only the tyre beads were still attached to the wheels and therewas considerable damage to the wheel rims. On wheel No 8 therewas a pattern of even wear damage around the circumference ofthe rim where it had worn while rolling along the runway. Incontrast, the rim of wheel No 7 was fragmented with numerous anddistinct fracture surfaces. On both wheels, a small area hadworn flat where each rim had suffered rapid abrasion as the lockedwheel had briefly skidded across the runway surface.

Witness marks around the wing and fuselage showed where a numberof fragments had struck the airframe. Most of the impacts werefrom pieces of tyre striking the landing gear doors and the undersurfaces of the wing and inboard flap and aileron; the damagefurthest forward was to the

translating cowl of the No 3 engine. There had also been damage from a substantial rim fragment ofwheel No 7 passing through both surfaces of the inboard flap.

Although the fragments of tyre and wheel rim had been removedfrom the runway soon after the accident, the airfield operator(HAL) had prepared a diagram showing where the items of wheelrim had been found. This diagram showed a regular distributionalong the runway of the fractured pieces of rim from wheel No7, consistent with the scoring of the runway surface and indicatingthat the fragmentation of this wheel rim had not been not thecause of the tyre failure but as a consequence of it. The samediagram showed the main carcasses of the tyres Nos 7 and 8 asa single cross, reportedly within some 20 metres of each other,consistent with very rapid failure of the second tyre after thefailure of the first. No obvious FOD items (apart from the wheeland tyre debris) were identified, which is not unusual for thistype of incident.

The fracture surfaces of the wheels themselves were examined atAAIB and in greater detail by the wheel manufacturer in the UnitedStates. These examinations confirmed that the rim failures wereas a result of the tyre failures and the manufacturer reportedthat "both wheel assemblies exhibited damage that is producedby rolling on the bare rim. All of the fractures exhibited ductile,tensile fracture. No evidence of fatigue was found.". Thedifference in damage between the two wheels, where the rims ofNo 7 had fragmented and the rims of No 8 had worn evenly, wasconsistent with difference in design: the No 7 wheel was manufacturedin the 1970s, before the "roll-on-rim" design was introduced,whereas it appears that the No 8 wheel was of later manufacture,with improved "roll-on-rim" capability. Unfortunatelythe detail part numbers of the No 8 wheel had been worn away duringits roll along the runway.

The tyres from wheels Nos 7 and 8 were examined at the AAIB andthen at the tyre manufacturer's retread facility in the Netherlands. The difference in pattern used in the interior bladder linersallowed the major items of tyre debris to be sorted and then reconstructed. On either tyre the detail examination revealed none of the signswhich are characteristic of abuse, of re-treading problems orof manufacturing defects. On tyre No 8 there was a local fracturepattern indicating some form of foreign object damage to the treadand then to the carcass cords; there was no similar pattern intyre No 7, indicating that this tyre had failed due to suddenadditional load when an adjacent tyre (No 8) failed.

This sequence of failure, where the No 8 tyre failed due to foreign-objectdamage and tyre No 7 then failed due to sudden additional load,appears the most likely explanation of the initial event. Itis also consistent with the distribution of the tyre fragmentsat the site and the pattern of tyre and wheel marks along therunway.

Previous examples

In this instance the aircraft was brought to a stop safely withinthe confines of the runway. Damage from the tyre and rim failures,whilst significant, did not seriously hazard the aircraft. Forcomparison study was made of the accident reports of two previousoccurrences involving; the accidents to Continental AirlinesDC-10-10, N68045, at Los Angeles on 1 March 1978 (NTSB-AAR-79-1)and to Pan Am DC-10, N 83 NA, at London Heathrow on 16 September1980 (AIB AAR 2/82). Both earlier accidents were more seriousin that fires started and passenger injuries occurred during theemergency evacuations. A distinctive common factor between thethree occurrences was that the failure of one tyre resulted inthe rapid failure of its 'mate' tyre on the same axle; the maindifference was that the more serious 1978 and 1980 occurrenceswere at speeds close

to V_1 (peak recordedairspeeds of 159 kt and 171 kt respectively) whereas thisoccurrence, to PP-VMD, was at a lower speed, some 30 kt belowV_1.