No: 7/92 **Ref: EW/A92/3/1** **Category: 1a**

Aircraft Type and Registration:	Boeing 737-400, G-UKLA
No & Type of Engines:	2 CFM56-3-C1 turbofan engines
Year of Manufacture:	1988
Date & Time (UTC):	9 March 1992 at 1610 hrs
Location:	Rome Ciampino airport
Type of Flight:	Public Transport (Charter)
Persons on Board:	Crew - 9 Passengers - 113
Injuries:	Crew - None Passengers - None
Nature of Damage:	Right main gear outboard tyre, gear door, inboard ground spoiler and inboard flap sections
Commander's Licence:	ATPL(A)
Commander's Age:	44 years
Commander's Flying Experience:	12,184 hours (of which 1813 were on type) Last 28 days - 59 hours Last 90 days - 93 hours
Information Source:	AAIB Field Investigation

History of the flight

The aircraft had been chartered by an Italian travel agency to take a party from Milan to the Canary Islands. The schedule for the day was to fly 3 sectors: London to Milan, Milan to Arecife and Arecife to Gatwick. The intention was that the schedule would be flown by one crew, but to allow for any significant delay two additional pilots were on board in the passenger cabin. The operating pilots at the time of the accident were a captain, undergoing line training, in the left hand seat and the commander, a training captain, who occupied the right hand seat.

The positioning flight to Milan was uneventful but on arrival it transpired that the tour agent had mistakenly directed some passengers to report to Rome Ciampino airport. The commander therefore obtained permission to fly to Ciampino to collect the remaining passengers. This flight was also uneventful. At Ciampino, whilst the extra passengers embarked, the commander carried out the pre-departure inspection and noted that the tyres appeared satisfactory and that the mainwheels were 'cool'. Almost an hour after arrival, the aircraft was taxied off the stand in a right turn, through 210°, without the use of asymmetric thrust or wheelbrakes. The crew prepared the aircraft for a flaps 5/full thrust

/bleeds-on take-off, at 57.1 tonnes AUW. The handling pilot was to be the captain under training; the fuel load was 12 tonnes and the speeds for take-off were V_1 138 kt, and V_R 144 kt.

The take-off proceeded normally until just after V_1 when the commander felt a slight 'bump', which he described as similar to the effect of running over a runway light. At about the same time, the handling pilot felt a brief vibration through the control column. The subsequent rotation, climb to flap retraction height and acceleration were normal and the crew remained unaware of any problem until the airport's tower controller advised them that the aircraft had left debris on the runway. Shortly afterwards one of the other pilots came forward to the flight deck and reported visible damage to the upper surface of the right wing, adjacent to the inboard ground spoiler. The crew declared an emergency and levelled the aircraft at FL 260 and 250 kt. The autopilot was disconnected and the aircraft carefully scrutinised for any 'out-of-trim' condition, damage, or system malfunction. No defect was evident and so the speed was increased to 280 kt.

After inspection of the visible damage to the right wing and an unsuccessful attempt to view the mainwheels, using the main gear viewer in the passenger cabin floor, the commander concluded that the right main gear had probably suffered severe tyre damage. He decided that a precautionary landing would have to be made using minimal wheelbraking, possibly with flap extension limited to 5°, and that they should prepare for some degree of directional control difficulty during the landing. It was apparent that such a landing would require a longer runway than that available at Arecife and so the commander decided to divert either to Palma, which was en-route, or to Gatwick. After consultation with the operating company by HF radio, he decided to continue to Gatwick. Direct routing and choice of flight level were offered by France Control and the commander opted to descend to FL 200 in order to avoid a long hold at Gatwick whilst burning-off excess fuel. He also decided to manage the fuel so as to arrive at Gatwick with 300 kg more fuel in the left wing tank than in the right so as to minimise any tendency for the aircraft to roll to the right, due to the damage to the right wing and its high-lift devices.

The commander wanted to avoid unnecessary alarm to the passengers by broadcasting instructions in a language with which they were not fluent, but there were no Italian speakers amongst the crew. After consulting the senior cabin crew member (SCCM), he enlisted the assistance of two of the tour agents. He briefed them and the SCCM on the extent of the known damage, the need for the diversion and the need to adopt emergency landing procedures. He then asked the SCCM to prepare a draft of the instructions for a full emergency landing and for the tour agents to translate this, and the SCCM's, instructions into Italian. About 75 minutes before the ETA at Gatwick the commander made his announcement in English and this was immediately followed by the Italian translation.

Soon afterwards the crew were contacted by their company on HF radio and instructed to divert to Stansted. The commander instructed the captain-under-training to hand over to the other, more experienced, captain and to occupy the 'jump' seat. The additional pilot was instructed to sit in the rear of the passenger cabin and to monitor the flaps during extension for any additional damage. When the aircraft was about 150 nm from Stansted, the commander contacted Stansted ATC by VHF radio and advised them that he required a 'full emergency standby' in addition to an engineer and a tow-truck to meet the aircraft, which he intended to bring to a halt on the runway. He then briefed the left seat pilot to make a flaps 40 landing with the automatic spoiler and wheelbraking systems disarmed. Maximum use of reverse thrust was to be used to stop the aircraft, with minimum use of the wheelbrakes.

On handover to London Control, the aircraft was vectored towards a long-finals position for an ILS landing on Stansted's runway 23 where the wind was 200/10 kt and the weather fine. Contact was made with the tower and the emergency services at 12 nm finals and the crew configured the aircraft with gear down and flaps 15° in level flight at 3000 ft. On intercepting the glide path, flap was lowered in stages through the 25°, 30° and 40° positions. A tendency for the aircraft to roll to the right was first noticed with flaps 25°, and this tendency increased with further flap extension, until at flaps 40° the aircraft required approximately 50% of control wheel input to retain a wings-level attitude. The commander decided that the asymmetry was too great and the flaps were reduced to 30° where control became, in his judgement, satisfactory. The approach was continued at V_{REF}+ 5kt until the flare when it was allowed to bleed back to V_{REF}. The cabin crew were ordered to take their seats as the aircraft passed the outer marker and the passengers were instructed to adopt the "brace" position at 100 ft agl. The commander's brace instruction was repeated by the cabin crew.

Touchdown occurred at approximately 1918 hrs at 45.2 tonne AUW, with 4.0 tonnes of fuel. Initially, the aircraft was landed on the left main gear only. Symmetric reverse thrust of 80% N1 was applied and then, after losing some 25 kt, the right main gear was gently lowered, followed by the nose gear. There was no appreciable swing and directional control was maintained by use of the nose wheel steering tiller.

The aircraft stopped about two thirds of the way down the runway and the parking brake was set. The fire crews took station ahead and to the side of the aircraft and reported that there was no fire or smoke apparent. A ground engineer inspected the aircraft and then advised that it was not safe to taxi, or to have the aircraft towed, with the passengers on board. The engines were then shut down in preparation for normal passenger disembarkation using the forward airstair.

Examination of the aircraft

The right outboard mainwheel tyre was found to have suffered a complete tread separation, although the tyre itself had remained inflated throughout the flight and subsequent landing at Stansted. The lower half of the gear leg door had been torn off by the tread as it had detached, and was found among the debris on the runway at Rome. The inboard flap assembly had also been struck by sections of tread, denting the fore-flap and trailing edge flap. Ahead of the flaps, damage had also been caused to a 'falsework' panel on the wing undersurface. The inboard ground spoiler, located almost directly above, had a 10 inch hole in its trailing edge. No damage had occurred to the hydraulic pipes that are attached to the undercarriage support beam, although their position clearly rendered them vulnerable to damage from flailing tyre fragments. The CAA SDAU Database lists five incidents since 1977 which involved tyre bursts, or tread shedding, on Boeing 737 aircraft and in which hydraulic systems have been damaged.

The subject wheel assembly was fitted to G-UKLA in November 1991 and the tyre, which was on its second 'retread', had failed after 236 landings.

The tyre tread debris was subsequently returned from Rome, and was examined with the tyre carcass by the tyre manufacturer in the presence of the AAIB Inspector. The tread sections were reassembled onto the carcass, and it was found that approximately 10% of the tread area was missing. However, laboratory examination of the recovered tread indicated a number of cuts consistent with the tyre having run over foreign object(s). A small hole, which was within this damaged area in the central tread region, was considered to have precipitated the tread separation. The object that had caused this hole had penetrated the two outermost casing plies. This had generated a localised area of inter-ply looseness which, under the action of centrifugal force, had developed into two tears which followed the bias of the casing ply, running approximately 33° either side of the tread centre-line. The separation had then progressed around the circumference of the tyre. Some of the other cuts apparent in the tread could have been made by debris from the aircraft during the tread flailing sequence.

Since the tyres had been deflated by maintenance personnel shortly after the aircraft had landed at Stansted, there was no record of the tyre pressures at the time of the incident. It was noted, however, that the intact tyre on the same axle as that which had failed showed evidence of excessive wear on the tyre 'shoulders'. This suggested that this tyre had been run in an under-inflated condition at some stage, although no connection could be established between this wear and the tread failure on the adjacent tyre.

It was not possible to establish where, or when, the latter tyre had suffered the damage which had led to the tread failure, although the tyre manufacturer expessed the view that this was likely to have been within the last one or two departures.

This was the latest of a large number of similar tyre failures recorded by the tyre manufacturer. In their experience, most of the debris that causes tyre damage is found not on the runways or taxiways, which tend to be swept fairly frequently, but in the passenger embarkation and maintenance areas. Examples of objects found in such areas included nuts and bolts, panels, fasteners and brake cylinders, and illustrate the need for vigilance on the part of both maintenance personnel and flight crews during their pre-flight inspections.