Airbus A300-600, N70072

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Aircraft Type and Registration:	Airbus A300-600, N70072
No & Type of Engines:	2 General Electric CF6-80-C2D1B turbofan engines
Year of Manufacture:	1989
Date & Time (UTC):	9 July 1998 at 1145 hrs
Location:	Climb out from London Heathrow Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 11 - Passengers - 174
Injuries:	Crew - Nil - Passengers - Nil
Nature of Damage:	Main landing gear brakes and tyres
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	18,570 hours (of which 208 hours were on type)
	Last 90 days - 170 hours
	Last 28 days - 71 hours
Information Source:	AAIB Field Investigation

History of flight

The crew were operating a scheduled flight from London Heathrow (LHR) Airport to Logan International Airport, Boston, USA; the weather was good with a light south westerly surface wind for take off. There were no significant defects in the technical log and the aircraft appeared fully serviceable during the external and pre-start checks. Both engine starts were normal and the commander taxied out to Runway 27 Left. He was the handling pilot for the sector and used reduced power for a normal take off at 1137 hrs.

Everything appeared serviceable during the take off and initial climb but, as the aircraft climbed through Flight Level (FL) 100, the first officer saw the right 'Oil Filter Clog' caution light illuminate and reported this fact to the commander. Initially, the light flickered on and off, as did the indication on the Electronic Centralised Aircraft Monitor (ECAM). However, after a short time, both the 'Oil Filter Clog' light and the ECAM indication remained on and steady. The crew checked the other engine indications but they were all normal; additionally, there were no asymmetric handling indications and no abnormal vibration. With clearance from ATC, the commander

levelled N70072 at FL 150. Then, with the caution still indicating, the commander instructed the first officer to action the appropriate emergency drills. Initially, this required the No 2 throttle to be retarded to a position at which the caution light would go out. However, with the throttle at idle the light continually flickered on and off. Then, after 3 minutes at idle, the 'Oil Filter Clog' light was on and steady and the commander, in accordance with the emergency drills and in consultation with the first officer, decided to shutdown No 2 engine. With the commander retaining handling duties, the first officer actioned the appropriate drills.

After the drill was completed, the crew declared an emergency to ATC and stated that they wished to return to LHR; they were given full co-operation by ATC. Then, with the aircraft established back towards LHR, the commander briefed the purser on the situation and of his intentions, and informed the passengers. The recovery was uneventful and the aircraft landed on Runway 27 Right at LHR at 1230 hrs. The LHR emergency vehicles had been alerted by ATC and had pre-positioned on the taxiway adjacent to the western end of the runway.

The aircraft weight on landing was 368,000 lb and the crew used a configuration of Slat 15/ Flap 20 with a Vref speed of 166 kt. Normal maximum landing weight is 308,700 lb but, with no fuel jettison system, overweight landings are permitted in an emergency at any weight within the maximum take-off weight of 378,590 lb. For the landing, the crew had preselected the autobrakes to the 'LO' setting, thereby selecting a deceleration rate of 1.7 m/sec^2. The crew assessed the touchdown as smooth, at less than 300 feet/min rate of descent and within 1,500 feet of the threshold; speed on touchdown was approximately 165 kt and the surface wind was reported as 240°/13 kt. On the ground, the first officer confirmed that the spoilers had deployed and the commander selected medium reverse thrust on the left engine. The crew recalled that the autobrake had disconnected following the commander's use of manual brake during the ground roll and the first officer then selected 'Brake Fans'. Neither crew member considered the retardation as excessive and, although the commander was confident that he could have turned the aircraft off the runway early, he allowed it to roll to the last exit. As N70072 was turned off the runway, ATC advised the crew that there were no visible problems and transferred them to the Airport Fire Service (AFS) frequency; as they cleared the runway, the crew noted that the left brake temperatures were normal but that all four right brake temperatures were indicating at the gauge maximum of 700°C.

Once clear of the runway, the crew brought the aircraft to a halt, established contact with the AFS and informed the fire officer of the brake temperature indications. The fire officer confirmed that there was smoke coming from the right main landing gear area and asked the commander to keep N70072 stopped and to shut down the left engine to allow the AFS unhindered access to the aircraft. Shortly afterwards, the fire officer reported to the crew that there was a small fire in the area of the right gear but that it was under control. The commander confirmed with him that there was no need to evacuate but then briefed the purser and asked her to be prepared to react quickly if the situation changed. Thereafter, the flight crew maintained a close liaison with the AFS and the cabin crew. The AFS used water to cool the brakes and stayed in attendance until the passengers had disembarked normally through door 4L using portable steps.

Flight recorders

The CVR was an A100 with a recording duration of 30 minutes. The recording began 10 minutes before touchdown and contained the recording for the period of landing and roll out, and also the initial conversations between the fire crew and the flight crew as the aircraft was stopped. The flight crew reported brake temperatures of 700°C on the right hand side during the landing roll out.

The FDR, an Allied Signal UFDR was replayed. The tape was removed from the recorder as initial attempts to replay had resulted in the tape 'coning' such that the tape was no longer aligned with the replay head. The tape was replayed successfully on the AAIB 'open reel' system, however there were some areas of bad data on the incident flight. There were no recorded parameters relevant to the brake pressures and temperatures.

The recording indicated that aircraft touched down at an airspeed of 173 kt and the pilot selected reverse thrust 2 seconds after touchdown. The longitudinal deceleration recorded a maximum of 0.413 G (4.05 m/sec^2) 8 seconds after touchdown. This decreased then to around 0.2 G as the aircraft decelerated through 100 kt, and decreased further as the aircraft rolled to the end of the runway. Rudder deflection initially fluctuated around neutral and then, after the airspeed had decreased to 100 kt, remained generally between 6-10° right for the remainder of the ground roll. The aircraft turned off the runway around 2 minutes after touchdown.

System description

The scavenge oil filter forms part of the lubrication system of each engine and there is an associated caution system on the flight deck to indicate clogging of the filter. This system is intended to warn of excessive debris in the oil that could be indicative of engine component break-up and is operated by an electrical switch actuated by excessive oil pressure differential across the filter. It is intended that the switch will make (switch on the caution) at an increasing differential of 33 psi, and switch off at a decreasing differential of 22 psi.

The aircraft's main landing gears (MLG) each have four wheels, mounted on two axles carried on a bogie beam. Each wheel fits over a multi-plate carbon-carbon disc brake and is provided with an internal shield to thermally insulate the wheel from the brake pack. An optional brake cooling fan was fitted to each of N70072's MLG wheels, manually selectable from the flight deck with the landing gear in downlock. Fusible plugs in the wheel flange deflate the try (nominal inflation pressure 175 psi) on reaching 183°C (361°F); additional fusible plugs in the wheel rim operate at 300°C (572°F). A thermocouple associated with each wheel supplies a signal to a brake temperature indication system that provides flight deck indication of individual brake temperatures and caution indications if any brake temperature reaches 300°C (572°F) or above. The autobrake system automatically applies brake pressure during ground roll; with 'LO' selected, braking is applied 3 seconds after the ground spoiler deployment command to provide an aircraft deceleration rate of 1.7 m/sec^2. Manual operation of brake pedals causes de-activation of the autobrake system.

Engineering investigation

Examination of the No 2 engine after the incident found no external signs of damage and detailed examination of the scavenge oil filter element and analysis of oil samples from the engine revealed no signs of abnormalities. Inspection and testing of the scavenge oil filter differential pressure switch reportedly found that it had shorted internally, apparently due to water contamination. After replacement of the switch the system and the engine operated normally.

Examination of N70072's right MLG showed that all four tyres had deflated, the brake units showed signs of having been overheated and the wheels, brakes and parts of the bogie were sooted. Markings suggested that grease from the axles had melted and run down. The evidence indicated that any fire had been small and of limited duration and had probably consisted of the burning of melted grease. It had not caused significant damage, except possibly to the brake units; the tyres had not been affected by fire.

The Aircraft Maintenance Manual (Section 32-40-00-6, Wheels and Brakes - Inspection/Check) noted that "Cross wind can result in a wide temperature difference between left-hand and right-hand legs."

The operator noted that it is fairly easy to over-lubricate the MLG wheel bearings as any grease displaced during lubrication remains hidden.

Previous cases

Information from the aircraft manufacturer indicated that there had been 20 previous cases reported of illumination of the scavenge oil filter clog caution light on aircraft with the CF6-80 engine. In some cases the caution had provided indication of a potentially serious failure, but in 9 of the cases the caution had been confirmed as spurious, ie not due to actual clogging of the filter.

Wheelbrake design requirements

The design case for wheelbrake energy absorption has generally been considered to be a rejected take-off (RTO) at maximum aircraft weight with brakes worn to allowable limits. However, it has been found that a landing at a weight in excess of the normal maximum landing weight where the normal landing flap cannot be deployed (and a higher touchdown speed is therefore required) can in some cases be somewhat more severe. This would be particularly relevant to aircraft types that do not have a fuel jettison facility. There has been no retrospective requirement for the landing case to be assessed for aircraft types certificated for the RTO case. Also, certification has not required consideration of the effects of crosswind or other yawing moments on energy absorption by the wheelbrakes; it has been assumed that the retardation energy is shared equally by all brakes. The airworthiness authorities have taken the view that consideration of factors that may prevent equal energy sharing from being realised in practice would create excessive complexity and that these factors are effectively accounted for by requiring testing with brakes worn to allowable limits. The airworthiness authorities reportedly did not normally consider a brake fire to be potentially serious unless tyre ignition were to occur.

Discussion

The incident occurred after an engine was shutdown in accordance with the aircraft emergency drills following an indication of a clogged scavenge oil filter. Subsequent examination revealed no engine damage and indicated that the illumination of the 'Right Oil Clog' caution light was probably caused by a short circuit due to water contamination. The caution was operated by a simple single channel system and the aircraft manufacturer reported that previous fleet experience had shown a spurious indication rate of approximately 50%. No other indicators were available to provide an independent confirmation of the caution. The potential benefits of a system to indicate clogging of the scavenge filter were not in doubt. Additionally, discussions with the manufacturer and the national authorities confirmed that the failure rate meets the certification requirements for ETOPS. Nevertheless, a procedure that requires one of the two engines of an aircraft engaged in Extended Twin Operations (ETOPS) to be shutdown would be expected to be based on a relatively high integrity warning system, or on the indications of two or more independent monitoring systems, rather than on a simplex amber caution system with a high spurious indication rate. Accordingly, it is recommended that:

Recommendation 99-21

Airbus Industry reassess the adequacy of the caution system intended to provide indication of engine scavenge oil filter clogging on the Airbus A300 aircraft and other types with a similar system. The assessment should take into account the procedure requiring engine shutdown on an ETOPS aircraft in the event of the caution system light remaining illuminated with the throttle at idle for three minutes.

The landing was at an aircraft weight above the normal landing weight but within the emergency limits; the full available length of 12,802 feet was used for the landing ground roll and retardation was not excessive. However, the brake temperatures reached at the end of the roll, normal on the left but sufficiently excessive on the right to activate the fusible plugs and deflate the tyres, made it clear that most of the braking retardation had been absorbed by the right brakes. This was consistent with asymmetric braking having been the predominant means of reacting the left yawing moments applied to the aircraft during the ground roll by the crosswind and by asymmetric reverse thrust. It was also in accordance with the note in the Aircraft Maintenance Manual. It would have been possible to maintain symmetrical braking by leaving the autobrake system engaged and using rudder and/or nosewheel steering to keep straight, but the Aircraft Operating Manual did not indicate the merit of such a technique in these circumstances. The manufacturer considered that normal airmanship would dictate this action. However, there would be no disadvantage in amplifying the advice in the Operating Manual. Accordingly, it is recommended that:

Recommendation 99-22

Airbus Industry consider, for the Airbus A300 and other aircraft to which similar considerations apply, amplifying the guidance given to crews on aircraft handling during a ground roll with one engine shutdown with the aim of preventing excessive brake temperatures caused by asymmetric braking.

It was apparently possible that an overweight landing with restricted flap could be somewhat more severe than the traditional design case for wheelbrake energy absorption of an RTO at maximum aircraft weight with fully worn brakes. However, there has been no retrospective requirement for the landing case to be assessed for aircraft types certificated in accordance with the RTO case. Additionally, certification has not required consideration of the effects of crosswind on energy absorption by individual wheelbrakes. It is evident that use of differential braking to counter even a relatively mild crosswind effect can cause appreciable overheating of the brakes on one side and it appears possible that this could be a more severe case for individual brakes than the certification case of a symmetrically braked RTO with worn brakes. While a brake fire was reportedly not normally considered to be potentially serious unless tyre ignition occurred, it would seem beneficial to aim to avoid any fire under a wing containing fuel tanks. Therefore, it is recommended that:

Recommendation 99-23

The Federal Aviation Administration and the Civil Aviation Authority in conjunction with the Joint Aviation Authority review the requirements for aircraft brake system certification, in particular possible overweight landing situations. The review should cover the need to consider overweight landing situations on aircraft types certificated for the rejected take-off case, together with the effects of crosswind and asymmetric engine thrust during ground roll.