

Factual information

Occurrence:	2006086	Classification:	Serious incident
Date occurrence:	17-07-2006	Flight crew:	3
Place occurrence:	Amsterdam Airport Schiphol (EHAM)	Passengers:	0
Aircraft registration:	N516MC	Injuries:	0
Aircraft model:	Boeing 747-200F	Lighting conditions:	Daylight
Aircraft type:	Freighter aircraft		
Type of flight:	Scheduled cargo flight		
Phase of operation:	Take-off		
Damage to aircraft:	Major		

Synopsis

During take-off from runway 36L the aircraft experienced rupture of the aft tires on the left-hand body gear (LHBG), followed by damage to the wheel rims and one forward tire. The flap system and the fuselage were damaged by the wheel rim and tire fragments. The damaged flap system caused a flap asymmetry and roll moment. The crew dumped fuel and returned to the airport. During landing on runway 06 the remaining forward tire of the LHBG ruptured. Both runways were damaged substantially by the LHBG wheel flanges rolling on the runways.

Description of the occurrence

The aircraft with registration N516MC was operating a scheduled service from Amsterdam Airport Schiphol (EHAM) to Hartsfield-Jackson Atlanta International Airport (KATL). The take-off card indicates that the crew used an outside temperature of 29 °Celsius for the calculation of the take-off speeds. The aircraft took off from runway 36L at 14.23 hours UTC¹ with a take-off weight of 377,394 kg (just below the certified maximum take-off weight of 377,842 kg) and the flaps selected at 20 degrees, according flight data recorder (FDR) data.² According to the weight and balance sheet, all weight and balance figures were within limits during take-off.

During the take-off roll at approximately 140-150 knots, before the decision speed V_1 (152 knots), the crew felt some vibration on the aircraft as if running over runway centreline lights. The crew continued the take-off and after lift off, the landing gear was retracted. During climb out, air traffic control (ATC) notified the crew that debris had been found on the take-off runway. According to the captain, the gear had retracted normally and the aircraft systems revealed no abnormalities.

¹ All times in this report are universal time co-ordinated (UTC) unless otherwise specified. At the time of the occurrence, local time (LT) at Amsterdam Airport Schiphol was UTC + 2 hours.

² The FDR-data did not contain take-off, landing and fuel weights.

At 3,000 feet after the flaps were retracted to 10 degrees, a deflection of the control wheel was required to keep the wings level. The captain stated that aircraft systems notified an asymmetrical inboard flap problem. The indicated left inboard flap position was 5 degrees while the indicated right inboard flap position was 10 degrees. Both indicated outboard flap positions were 10 degrees. The flaps were reset to 20 degrees and the asymmetric flap checklist was performed. The crew decided to climb to 10,000 feet, kept the flaps at 20 degrees and depressurized the aircraft anticipating a possible pressurization problem.

The crew declared an emergency and informed ATC that they needed to dump fuel and return to EHAM. After fuel had been dumped, at 30 NM³ out, the flaps were set at 25 degrees and the landing gear was lowered. According to the captain the flap position indications in the cockpit were 5 degrees left inboard, 20 degrees right inboard, 20 degrees left outboard and 25 degrees right outboard. The crew made an ILS⁴ approach to runway 06 with a final approach speed of 182 knots. The touchdown was well within the touchdown zone. Medium auto brake was maintained till about 100 knots airspeed. Because thrust reverser #2 was inoperative, only thrust reversers #1 and #4 were used. Reverse thrust was applied till about 60 knots airspeed. The aircraft stopped in front of the fire trucks with 1,000 to 1,500 feet of runway remaining.

The captain stated that the evacuation checklist was performed but that they did not abandon the aircraft on request of the fire brigade which they were in contact with.

The landing was at 15.40 hours UTC. According to the Aircraft Maintenance Log (AML) an overweight landing had been made with a gross weight of 288,000 kg. The certified maximum landing weight was 285,762 kg. The captain stated that he had expected to burn more fuel on the way from the fuel dumping zone to EHAM because the flaps and landing gear were extended early for landing.

Remnants from tires and wheel rims were found on the departure runway 36L. After landing, the left-hand body gear (LHBG) tires were found ruptured and the aft wheel assemblies were fractured. All thermal plugs⁵ of the left-hand wing gear (LHWG) and right-hand body gear (RHBG) had released the tire pressure. Parts of the flap system of the left wing and parts of the fuselage were found damaged. During the take-off from runway 36L and the landing on runway 06 the aircraft damaged both runways substantially, due to the wheel flanges contacting the runways.

The flight engineer (F/E) mentioned that he had performed the pre-flight inspection and noticed that all tires were in good condition, except one tire which was worn more extensively than the others. He could not recall which tire this was. According to the F/E, taxi-out to the departure runway was a long distance, but they did not apply the brakes, so the brakes were in 'good shape' for take-off. The F/E emphasized that there had not been unusual pressure and temperature indications. According to the F/E, the little vibration, which was felt during the take-off roll, was considered by the crew to be nose wheel shimmy.⁶

³ NM stands for nautical mile. 1 nautical mile = 1,852 metres.

⁴ ILS refers to Instrument Landing System.

⁵ A thermal plug is a safety device in braked wheels, containing a low melting point metal. If the wheel gets excessively hot, (150 – 200 °Celsius) mainly by excessive braking, the low melting point metal melts and prevents bursting of the tire.

⁶ Nose wheel shimmy is an abnormal oscillation of the nose wheel.



Illustration 1: Left hand body gear



Illustration 2: Damaged parts of the flap system

Investigation and analysis

The investigation being conducted by the Dutch Safety Board (DSB) focussed on the occurrences during the take-off from runway 36L. Investigated were the fractured left-hand body gear aft wheels, the corresponding brakes and the remnants of the burst tires.

Underlying organizational factors, maintenance of the aircraft and the supervision by the U.S. Federal Aviation Administration on the U.S. aircraft operator involved, were not investigated.

The National Transportation Safety Board (NTSB), representing the State of Manufacture, State of the Operator, State of Design and State of Registry participated in the investigation of tires, wheels and brakes of the LHBG.

The FDR and cockpit voice recorder (CVR) were removed from the aircraft and taken to the Bureau d'Enquêtes et d'Analyses (BEA) in Paris, France, where they were read out. The whole flight was recorded by the FDR and the CVR.

According to the AML of N516MC, the aircraft had experienced a rejected take-off at Miami International Airport, Florida, USA (KMIA) the week before on 10 July 2006. During taxi out, there was no indication of dragging brakes; the brake temperature and pressure indications were normal. The flight crew involved reported that the aircraft was extremely slow in accelerating. It was pulling left and needed a lot of right rudder input. When the indicated airspeed was 80-85 knots, the captain decided to abort the take-off and the aircraft came to a stop on the runway. The brakes did not release until several attempts at pressing on the brake pedals. When taxiing back to a parking spot, the brake temperature gauges of the left wing and body gears were in the red scale, indicating that wheel thermal plug release may occur. All other brake temperatures were normal. As a corrective action the left brake metering valve was replaced.

The AML showed as well:

- *left-hand brake metering valve problems on 12 July 2006;*
- *left-hand front brake on right wing gear overheated on landing, indication of 7.25, on brake temperature indicator 11 July 2006;*
- *per MCC⁷ request, check left-hand wing gear wheels and brake for rotation 11 July 2006. Corrective action: wheels rotated with low effort;*

⁷ MCC stands for Maintenance Control Centre.

- *per MCC request; check left-hand body gear wheels and brake for rotation 11 July 2006. Corrective action: wheels rotated with low effort.*

On request of the DSB, Goodyear Aviation Tires in the Netherlands inspected the tire pieces of N516MC that were found on runway 36L. Goodyear concluded:

- *The tire pieces on runway 36L came from three different tires;*
- *Based on the rubber reversion found in some of the tire pieces, heat degradation had affected the integrity of at least one tire;*
- *Two of the tires broke up due to heat damage and the third one mainly due to mechanical (centrifugal) forces;*
- *The inspection of the tire pieces did not reveal any tire problem existing before the take-off.*

In order to determine the sequence of events, the cause of fracture of the wheel rims and if any material or processing discrepancies contributed to the fractures, the four damaged wheel and brake assemblies, and all of the debris collected from the runways were shipped to the Boeing Equipment Quality Analysis Laboratory in Everett, Washington, USA for examination. The corresponding report stated that:

- For each of the four wheels, all six fuse plugs and one over-inflation plug were present and appeared to be intact;
- Fragments from all four tires exhibited a diamond shaped appearance consistent with a burst under pressure;
- On all four wheels, the damage was consistent with a burst tire, roll-on rim condition;
- The two aft tires showed evidence of intense heat in multiple locations and multiple layers with bluing and melted nylon consistent with the tire being operated in an over-deflected condition;
- The two forward tires showed some minor evidence of localized bluing and brittle nylon.

The group that performed the examination concluded that the tires broke up first, followed by the fracture of the aft wheel assemblies. The wheel assemblies fractured after most of the tires had departed and the rims contacted the runway at high speed. The absence of cuts on the exterior of the tires indicated that the rupture of the tires was not caused by any foreign object. No pre-existing damage in the fractured wheels was found and no material or processing defects were discovered during the examination.

Analysis by DSB

Underinflation/overdeflection of a tire results in excessive deflection of the shoulders and sidewalls and increased internal heat generation. This deflection and heat can degrade the physical properties of the tire and result in ply separations, pressure loss and/or tire burst. Pre-existing internal heat damage could have been present in some/all of the tires, caused by operation in an underinflated/overdeflected condition which may have been intensified by the long taxi distance. This damage however was probably not visible from the outside.

During the take-off roll involving a relatively high take-off weight, the effects of previous or current underinflation/overdeflection were most likely the cause of the rupture of the #8 tire (aft inboard) followed by rupture of the #7 tire (aft outboard) due to the resulting overload (and possibly pre-existing internal damage due to being operated in an underinflated/overdeflected condition). Tire #6 (forward inboard) may have then failed due to foreign object debris (FOD) from the #7 and/or #8 wheels and tires. Tire #5 (forward outboard) may have also been damaged by FOD, and would have been subjected to overload following the deflation of tire #6.

After the occurrence the six fuse plugs and over-inflation plug of each wheel were present and appeared to be intact. This means that the tires burst before the pressure had been reached to start the overinflating plug working.

Conclusion

Based on the conclusions of the examinations by Goodyear Aviation Tires in the Netherlands and those at the Boeing Equipment Quality Analysis Laboratory, the Board concludes that N516MC experienced rupture of the aft tires on the left-hand body gear (LHBG), followed by damage to the wheel rims and one forward tire during take-off from runway 36L. The flap system and the fuselage were damaged by the wheel rim and tire fragments. The damaged flap system caused a flap asymmetry and roll moment. During landing on runway 06 the remaining forward tire on the LHBG ruptured during the landing roll out.

The Board is of the opinion that the cause of the occurrence is that one or both of the two aft tires of the LHBG were operated in an overdeflected/underinflated condition at some point and may have had pre-existing damage, before the occurrence flight.

The combination of tire underinflation damage, the high take-off weight and the long taxi distance caused failure of these tires during the take-off roll. This was later followed by fracture of the wheel rims. Consequently the forward inboard tire failed. The forward outboard tire failed during the landing due to effects from FOD and/or overload.

The Board was not able to determine if a link actual exists between the occurrence in question and the rejected take-off at KMIA on 10 July 2006 with its wing and body gear wheels, brakes and metering valve problems as written in the AML.

The Board emphasizes the importance of correctly checking the tire pressures during the pre-flight inspection.