

Beechcraft Duke, G-IASL

AAIB Bulletin No: 9/97 Ref: EW/C97/6/4 Category: 1.3

Aircraft Type and Registration:	Beechcraft Duke, G-IASL
No & Type of Engines:	2 Lycoming T10-541-E1A4 piston engines
Year of Manufacture:	1968
Date & Time (UTC):	9 June 1997 at 1617 hrs
Location:	Southampton (Eastleigh) Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - 2
Injuries:	Crew - None - Passengers - None
Nature of Damage:	Damage to right main landing gear, flap, aileron, propeller and wingtip
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	35 years
Commander's Flying Experience:	7,000 hours (all on type) Last 90 days - 165 hours Last 28 days - 39 hours
Information Source:	AAIB Field Investigation

History of the flight

The aircraft had been positioned at Shoreham with a specialist painting organisation for some seven weeks prior to the accident, for a complete respray and change of registration (from 'G-SING'). For most of that time it was reported to have been parked outside. On the day of the accident the pilot, the owner and an associate travelled to Shoreham to collect the aircraft with the intention of flying it to Exeter. The owner had recently taken a checkflight, including flight with reference to instruments, with a QFI but as his medical was out of date he asked the pilot to accompany him to Exeter and then re-position the aircraft back to Fair Oaks. Although the pilot had not flown this particular aircraft type before, he studied the Pilot's Operation Handbook (POH) at length and intended to allow the owner to handle the aircraft on the first leg whilst he supervised the flight and further familiarised himself with the aircraft's systems. On arrival at Shoreham the aircraft was examined in detail and apart from a missing cowling fastener, which was quickly replaced, and some paint overspray in the wheel wells, the aircraft appeared to be satisfactory. After re-fuelling

the aircraft was boarded, the owner occupying the front left seat, the pilot the front right seat and with the passenger in the second row seat behind the owner. With regard to the high performance nature of the aircraft and the minimal propeller ground clearance, the pilot elected to take off from the 18m wide hard Runway 21, although this was slightly 'out-of-wind'. Power checks were reportedly satisfactory and, at 1430 hrs, having stabilised take-off power with the brakes on, the take-off roll was commenced with the aircraft owner handling and the pilot monitoring. At about 80 kt the owner stated that his airspeed indicator (ASI) was not working. However, the pilot assessed that there was insufficient distance in which to safely stop and so took control. With approximately 200 metres of runway remaining and at a speed of around 90 kt he rotated the aircraft and climbed away. The gear and flaps were reported to have retracted normally and the engines were set to climb power. However a short time later, the owner drew the pilot's attention to a 'left engine low fuel pressure' caution which had illuminated on the main warning panel to his left. Although the engine appeared to be functioning normally and the manifold pressure and fuel flow appeared satisfactory, the pilot decided to return to Shoreham and advised the controller accordingly.

When the aircraft was downwind and the landing gear was selected down, only two green lights for the left main and nose landing gears illuminated and the 'gear in transit' light remained on. The gear was therefore re-cycled, but with the same result, and so a fly-past of the control tower was made for a visual check. Although the controller reported that the gear appeared to be down, the pilot decided to leave the circuit in order to investigate the problem further. The left engine appeared to be running normally, however as a precaution the electric fuel pump was left on. As the left ASI was now working, control of the aircraft was returned to the owner who flew the aircraft in a holding orbit over the coast. Meanwhile, the pilot read through the alternative gear lowering procedure in the POH and, with the assistance of the passenger, attempted to extend the landing gear using the handcrank located behind the right front seat. This procedure requires the crank to be turned through approximately 50 turns to lock the gear down but, after approximately 30 to 35 turns, the handle became too stiff to operate. Gentle positive and negative 'g' were applied to the aircraft in addition to yawing it left and right at 140 kt, but to no avail. The right gear remained unlocked. At this point the pilot realised that an emergency landing appeared inevitable and, although the fuel pressure warning persisted, elected to land on a wider and more 'into wind' runway than that at Shoreham. The nearest such runway was at Southampton Airport and, after advising the tower, the pilot flew westward, leaving the gear down.

Nearing Southampton an emergency was declared to ATC, but the pilot was asked to hold off to allow time for an inbound aircraft to land and to give time for external fire appliances to arrive. Inbound to the circuit he requested another visual check of the gear, this time with the aircraft approaching the tower from directly ahead, whereupon he was immediately advised that the right gear was definitely not fully down. Whilst orbiting in the downwind position waiting for permission to commence the approach, control was again passed to the owner whilst a further review of the POH was carried out. This time the 'Raising Gear Following Practice Manual Lowering' drill was carried out, and the gear cycled again, but with no success. The pilot then briefed the passenger on the operation of the main door and asked him to secure the cabin and occupy the rear left seat adjacent to the door. He also instructed the owner, upon his command, to turn off the magnetos and electrical services just before touchdown. Final approach was made at around 90 kt with full flap. Just before touchdown, at about 85 kt, the pilot pulled both mixture levers to the cut-off positions. Touchdown on the runway was with wings level. Initially the aircraft tracked straight, but despite the application of full left rudder and aileron, the right gear collapsed and the aircraft began to veer off to the right. The aircraft left the runway at about 30 degrees to the centreline and, once on the grass, yawed rapidly to the right before coming to rest approximately 20 metres to the side of the

runway, having rotated through approximately 160°. There was no fire or spillage of fuel and the passenger quickly opened the cabin door and the occupants swiftly left the aircraft, the pilot verifying that the magnetos and all electricals had been switched off.

With the assistance of the Airfield Fire Service, and with the AAIB in attendance, the aircraft was raised using air bags. This enabled the right gear to be pulled into the down position, where it was locked by external means, and the aircraft was taken to a maintenance organisation on the airfield, where it was examined. The airfield was closed for approximately 2 hours.

Landing Gear Description

The tri-cycle retractable landing gear mechanism on this aircraft, as illustrated in Figure 1, is actuated electrically by a direct current (DC) motor through a gearbox mounted centrally in the fuselage beneath the front two seats. Attached to the output shaft on the upper side of the gearbox is a drive arm spider which operates push-pull rods to the two main landing gears (MLG's) and inner main gear doors, sequencing being achieved by the geometrical relationship between the levers. The nose gear is operated from a separate arm on the lower side of the gearbox. Each drive rod to the MLG's connects directly between the gearbox and an operating arm integral with the upper frame of the leg sidestay. This rod, at its outboard end, incorporates a compression spring arrangement, such that with the gear fully extended, the rod over travels slightly, foreshortens, and maintains a positive gear down force but without inducing excessive compressive loads in the rod. The gear is locked down by an articulated strut, as shown in Figure 2, which is pivoted at its upper end to the top of the landing gear, acting against a roller mounted from the sidestay centre joint pivot bolt, as the two sidestay segments align. The locking strut is pulled into 'lock', against the action of two torsional springs, designed to unlock the strut, by a small diameter cable signalled from the main gear inner door, as this closes. The final part of the sidestay travel is assisted by the action of the lock strut as it straightens, as shown in Figure 2, and a positive lock is sustained as long as tension is maintained in the cable. During extension, the lock strut torsional springs pre-position the end of the strut such that the roller may be captured by its shaped end before the lock strut straightens.

Aircraft Examination

After the aircraft had been raised on jacks, the front seats and sufficient panels were removed to expose the complete landing gear system, including the gearbox. This initial inspection revealed that the gear operating rod to the right MLG had failed, all associated evidence indicating that this had resulted from a single compression overload event sustained as the gear collapsed during the landing. As it did so, the inner door had been deformed into its aperture in the wing by the wheel. The failed operating rod was removed and the gear cycled using the normal system. The nose and left MLG were seen to retract and extend without problem with their respective green lights indicating normally. It was also verified that with the right MLG also in the fully down position, the 'gear in transit' light went off and its green light would illuminate, this being signalled from a switch operated by the upper frame of the sidestay and not by the lock strut itself. The emergency extension system was also used to satisfactorily extend the nose and left main gear, without any undue stiffness being detected.

With reference to Figure 3, it was apparent that both MLG's had been painted in-situ with fresh paint evident over the sidestays and lock struts. In some areas in the wheel wells, the old paint was wrinkled, suggesting that it had been affected by a paint stripper. In at least two places, grease nipples had been painted over, and there was no evidence of lubricant around any of the joints or

grease nipples. When operated directly by hand, the right gear was free to move, as was its sidestay, but there was slight resistance towards full travel and to articulation of the lock strut. The lock roller was found to be seized. The level of stiffness prior to the attempts to lower the gear in flight, the landing and manual engagement of the lock, could not be established. It was also apparent that the seized roller had, at some time since the aircraft had been painted, pressed heavily onto the paint on the upper surface of the lock strut. A comparison of the condition of the paint in this area between the left and right gear may be seen in Figure 3.

Since the right gear, sidestay and lock mechanism, including the cable from the inner door, had not failed, and the gear was observed not to have been fully down, then at the time of the landing the mechanism must have been configured as shown in Figure 4. The evidence indicated, therefore, that upon initial lowering the lock strut had failed to engage with the roller, probably due to stiffness in its joints, and that by the time the inner door was closed, higher than normal side loads were applied to the seized roller as a result of the lock strut being in the incorrect position. With high friction loads being induced, full travel of the outboard end of the operating rod was limited as its spring compressed, thereby failing to fully extend the landing gear, and preventing it from locking down.

Maintenance History

The most recent maintenance involving the landing gear, an Annual Check, had been carried out in August 1996, before the aircraft was sold to its current owners. At that time the operation and rigging of the system were recorded as being satisfactory and the aircraft's total time was recorded as 3002 hours. In addition, there had been no reported problems during the last landing some weeks earlier at Shoreham. The aircraft had flown for a total of some 41 hours (29 flights) between the Annual Check and the end of 1996 with no record of any problems associated with the landing gear, or of any maintenance on the gear. The history of the aircraft during 1997 had not been recorded in the log book.

Airworthiness Requirements

Airworthiness Notice No 38, issued by the Civil Aviation Authority in March 1994 (Issue. 2), gives details of Mandatory Action concerning the painting of aircraft. The CAA does not grant specific approval to organisations for the painting of aircraft, but specialist painting organisations are required to hold an A1, B1 or M1 approval if they have to issue a Certificate of Release to Service (CRS) following such painting. This requirement is based on an assessment of the proposed task by the owner, operator or approved maintenance organisation, taking into account the aircraft manufacturer's published requirements and precautions, in addition to the contents of paragraph 6 of Notice 38. The latter paragraph lists examples of 'likely damage and hazards that must be avoided' during painting operations. These include damage that could adversely affect the aircraft's structural integrity during preparation, uncontrolled weight variations, loss of correct mass balance moments on flight control surfaces and variation to surface profiles at critical points, such as surface leading edges, by the uncontrolled use of fillers, etc. The possible effects of paint on mechanisms, such as gear retraction systems, and the possible loss of lubricant during the preparation process is not specifically mentioned in this list of examples, although prior to the issue of any CRS it is regarded as axiomatic that the approved signatory should be satisfied as to the airworthiness of the aircraft, particularly with regard to any specific work undertaken.

It was reported that following painting, this aircraft was not jacked up to check the operation of the landing gear.

Safety Recommendation

As a result of these findings, the following Safety Recommendation is made:

97-28: In order to avoid adverse operating effects on landing gear systems which have been repainted, the CAA should amend Airworthiness Notice No. 38, paragraph 6, to include warnings of the possible effects of painting and related preparation treatments on landing gear lubricated mechanisms during 'in-situ' painting operations on aircraft.