Cessna 310L, G-AZUY

AAIB Bulletin No: 2/2004	Ref: EW/G2003/09/26	Category: 1.2
Aircraft Type and Registration:	Cessna 310L, G-AZUY	
No & Type of Engines:	2 Continental IO-470-VO piston engines	
Year of Manufacture:	1966	
Date & Time (UTC):	29 September 2003 at 1646 hrs	
Location:	Runway 25, Blackpool Airport, Lancashire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 4
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damage to underside of aircraft: inner main landing gear doors and tail cone assembly	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	63 years	
Commander's Flying Experience:	9,500 hours (of which 150 were on type)	
	Last 90 days - N/K hours	
	Last 28 days - N/K hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot, and follow-up telephone inquiries	

Synopsis

After selecting the landing gear to down in preparation for landing, the pilot initially saw three 'greens', but those for the main landing gear soon extinguished. All efforts to get the gear to lock down were not successful and, during the subsequent landing, the main landing gear collapsed. Subsequent investigation indicated that the landing gear 'down' cycle relay had probably stuck in the energised position and that this had resulted in overtravel damage to the landing gear gearbox.

History of the flight

The pilot reported that when he selected the landing gear to down, whilst on base leg for Runway 28 at Blackpool Airport, he initially saw the three green landing gear (MLG) 'down and locked' indication lights, but the indications for the MLG then extinguished.

The air traffic controller reported that when the aircraft was at about one mile on final approach, the pilot called up to say that he could not get 'three greens' and asked the controller whether he could see if the landing gear was locked down. The controller replied that the gear appeared to be locked, but he asked the pilot to carry out a fly-past for a closer inspection. The pilot declined this request, saying that he would prefer to continue with the landing. The controller put the airport fire service (AFS) on standby.

As the aircraft touched down, the controller saw the right landing gear starting to fold, and activated the crash alarm; however, the pilot lifted off again and the aircraft climbed away. The pilot later reported that when he selected the landing gear to up, this resulted in the nose gear green indication light extinguishing but, after selecting the gear down again, he got no green indications at all. An

attempt was then made to hand crank the landing gear into the extended position, but this was unsuccessful and it felt to him as though the gearbox was not operating. After unsuccessfully trying various manoeuvres to encourage the wheels to lock down, the pilot elected to land on Runway 25, which had no runway lights and therefore was less likely to cause damage. He informed the controller of his intentions and, at this stage, the controller upgraded the AFS emergency status and notified the external emergency services.

Half flap was selected for the approach, in order to minimise the risk of damage to the flap surfaces, and the aircraft touched down gently in a nose high attitude. The MLG collapsed and jammed against the inner landing gear doors, which cushioned the aircraft's contact with the runway. The nose gear did not fold and, after a ground run of approximately 100 metres, the aircraft came to rest without the propellers having touched the ground at any stage. Both the pilot and his passengers were able to vacate the aircraft without difficulty.

Landing gear description

The Cessna 310 is equipped with an electrically powered, mechanically actuated, tricycle landing gear, operated by a series of rods and bell cranks. The actuator comprises a geared mechanism, operated by an electric motor, mounted centrally in the fuselage with the output shaft positioned vertically and projecting through the top and bottom halves of the actuator casing. A double-ended bell crank is attached to the upper end of the output shaft, and operates each main landing gear via pushrods which extend outboard through the wing. These connect to mechanisms which both raise and lower their respective landing gear, and operate the up-lock or down-lock, as appropriate. A single-ended crank, attached to the lower end of the output shaft, connects to a similar mechanism that raises and lowers the nose landing gear. The actuator output shaft moves through an angular range of approximately 90°, and the system is rigged so that when the gear is fully extended the output cranks are aligned with the axis of their respective pushrods, thus minimising any loads on the actuator mechanism from forces generated by the landing gear.

The actuator itself comprises a worm gear on the input shaft, driven by a reversible electric motor, which engages with a gear quadrant on the output shaft. The limits of movement are controlled by a single pair of microswitches mounted on the casing of the actuator. These remove electrical power from the motor when the mechanism has reached the appropriate position for the 'fully up' or 'fully down' condition of the landing gear, as appropriate. The actuator motor is powered from the aircraft's main bus bar via a pair of relays, one each in the 'gear up' and 'gear down' circuits. Activation of these relays is controlled by the positions of the landing gear selector switch and the actuator limit switches. During landing gear extension only, a third relay introduces a load resistor into the motor circuit to moderate the speed of the actuator. Landing gear 'down and locked' indications (the three green lights on the instrument panel) are provided by separate indication-only microswitches on each of the landing gear downlock mechanisms.

A mechanical back-up system is provided in the form of a hand crank. The crank stowage mechanism incorporates a clutch which disconnects the drive from the electric motor and substitutes motion from the hand crank in its place. Mechanical limit stops are provided within the actuator body to prevent the worm from running off the end of the gear quadrant when the emergency hand crank is used. These stops should not come into abutment during normal operation via the actuator motor, the travel of the gear quadrant being limited by operation of the limit microswitches.

Aircraft examination

Post accident investigation carried out by the pilot, who was also an A and C Licensed Aircraft Engineer, found that the actuator gear quadrant had over-run, and broken through, the mechanical stops, allowing the worm to run off the end of the quadrant. He also found that all three of the electrical relays in the actuator motor circuit were prone to sticking when their 'yokes' were pressed hard down with the solenoids de-energised. He attributed the actuator motor overrun, and the consequent disengagement of the worm from its quadrant, to one of these relays having become stuck,

effectively disabling the limit switches. Because the actuator mechanism had become disengaged internally, the hand crank mechanism had been rendered ineffective.

It was not possible to identify directly which of the relays had probably stuck, but the fact that the landing gear had initially extended and three green indications had been achieved prior to the landing, albeit briefly, suggests that the relay powering the 'landing gear down' cycle was responsible. This would have briefly given three green indications as the landing gear reached the fully down position but, as the mechanism then over-ran limit stops and the output cranks rotated beyond their aligned position, the linkages would have started shortening again, breaking the downlocks, and effectively starting a retraction cycle. This left the landing gear not only in an unlocked state, but also with the actuator internally disconnected and incapable of resisting back-loads from the landing gears.