

## Cessna 310R, N234SA

<b>AAIB Bulletin No: 11/2003</b>	<b>Ref: EW/G2003/03/26</b>	<b>Category: 1.2</b>
<b>Aircraft Type and Registration:</b>	Cessna 310R, N234SA	
<b>No &amp; Type of Engines:</b>	2 Continental TSIO-520-BB piston engines	
<b>Year of Manufacture:</b>	1979	
<b>Date &amp; Time (UTC):</b>	13 March 2003 at 1550 hrs	
<b>Location:</b>	Nottingham Airport, Nottinghamshire	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - 2
<b>Injuries:</b>	Crew - None	Passengers - None
<b>Nature of Damage:</b>	Damage to left main landing gear, left propeller, left wing and horizontal tail	
<b>Commander's Licence:</b>	Private Pilot's Licence	
<b>Commander's Age:</b>	60 years	
<b>Commander's Flying Experience:</b>	890 hours (of which 72 were on type)	
	Last 90 days - 7 hours	
	Last 28 days - 2 hours	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

### Synopsis

After a firm but otherwise normal landing, as the aircraft was turned to the right to vacate the runway, the left main landing gear collapsed. The landing gear leg had probably been incorrectly rigged after major repair work arising from an earlier wheels-up landing.

### History of the flight

The aircraft was returning to Nottingham after a local flight. The pilot set up a visual approach to Runway 09 and selected full flap. The wind was reported to be from 090° at 15 kt. The pilot made, in his words, "a hardish landing" and touched down almost on the runway identification numbers with the stall warning horn on. He applied the brakes and then released them as he initiated a right turn to exit the runway onto the first taxiway. The pilot estimated that his groundspeed was approximately 10 kt when he initiated the turn. As soon as the aircraft started to turn the left main landing gear collapsed causing the left propeller and left wing to strike the ground. The aircraft came to rest on the runway. The pilot reported the collapse to the control tower and then, after completing the shut down procedures, he evacuated the aircraft with his two passengers. An eyewitness to the accident described the landing as "firm but nothing serious". The witness estimated that the aircraft's ground

speed at the start of the turn was more than 20 mph but less than 40 mph (17 kt to 35 kt). The distance from the pilot's estimated touchdown point to the point where the gear collapsed on the runway was approximately 240 metres (790 feet).

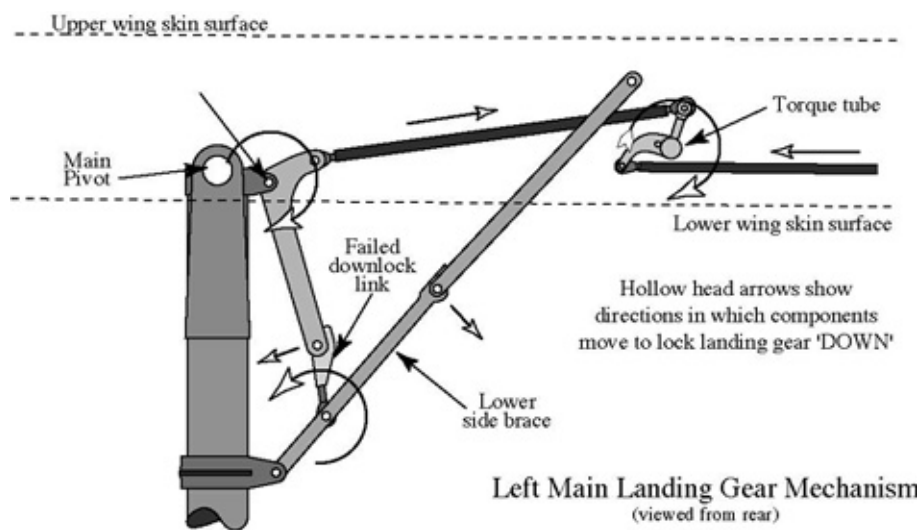
### Maintenance history

On 18 December 1995 the aircraft, under its previous registration of F-GGGG, suffered a wheels up landing at East Midlands Airport (see AAIB Bulletin 2/96). The aircraft was re-registered as N234SA in March 2002, eventually repaired, and issued with an FAA 'Standard Airworthiness Certificate' on 27 November 2002. The repair work included removing the wings, replacing the fuselage front spar, belly skins and damaged ribs. The main landing gear doors were repaired but no repair work was carried out on the main landing gear. The worksheets noted that the main landing gear was checked and rigged in accordance with the service manual. Several gear retraction tests were carried out and the system was deemed to operate satisfactorily. The aircraft was on its fourth flight and had just made its fourth landing, following the repair work, when the left main landing gear collapsed on the runway at Nottingham.

### Landing gear mechanism

The main landing gear on the Cessna 310 is held in the down and locked position by a side brace that is rigged to an over-centre position (see Figure 1). A downlock link applies pressure to the side brace to keep it in the over-centre position. The main landing gear rigging procedure is quite involved and covers nine pages in the service manual. The aircraft manufacturer contends that small deviations from the rigging procedure can lead to a situation where the landing gear will collapse as a result of the side brace coming out of its over-centre position.

**Figure 1**



### Aircraft Examination

The aircraft was recovered by the maintenance organisation and later inspected by the AAIB. The aircraft had sustained damage to its left wing tip and left horizontal tail, and the left engine propeller tips were bent backwards. The downlock link that supported the left gear lower side brace had failed at the threaded portion (see Figure 2). The pivot bolt securing the downlock link to the side brace had bent and the bush through which the pivot bolt passed had been plastically deformed downwards. Further minor damage inside the left main landing gear wheel well was noted.

**Figure 2**



A metallurgical examination of the fracture in the downlock link revealed that it had failed as a result of bending overload. The metallurgist reported that the overload had been applied through the pivot bolt in the eye end and the bolt itself had been plastically bent in the process. Vickers hardness tests were carried out on undeformed regions of both the threaded stud and the pivot bolt. The hardness values of both materials were consistent with a tensile strength of  $980 \text{ N/mm}^2$  (Newtons per square millimetre) which was considered to be normal. It was further noted that the length adjustment provided by the threaded stud was almost at its minimum length position - this would provide for a minimum movement of the side brace into the over-centre position.

### **Landing performance**

The landing performance of the aircraft was calculated to determine whether the pilot's reported speed of 10 kt upon initiation of the turn was achievable given the short runway distance leading up to the taxiway. The aircraft's weight at touchdown was approximately 4,700 lb. The runway elevation was 138 feet amsl and the temperature and wind were  $9^\circ\text{C}$  and 15 kt from  $090^\circ$  respectively. Given these conditions on Nottingham's paved level Runway 09, the predicted landing ground roll using full flap and maximum braking effort was 420 feet (Cessna 310R Flight Manual). The distance from the numbers to the point where the gear collapsed on the runway was approximately 790 feet. Therefore it would have been possible, with heavy braking, to slow to the reported groundspeed of 10 kt prior to turning off the runway.

### **Landing gear side load limits**

There is no published ground turning speed limitation for the Cessna 310R. The aircraft manufacturer stated that the side loads during most turns were very small when compared to the landing side loads imposed during a touchdown in a crab or a side-slip. The manufacturer could not state a turning speed limit as the loads would be a function of the sharpness of the turn and not just the speed. However, they did not think that a turn at 20 kt would result in the gear collapsing due to an excessive side load.

Both BCAR regulation 23.485 and FAA regulation 23.485 for ground side-loads state that the limit side inertia factor must be 0.83. A limit of 0.83 g would result in a speed limit of 30 kt assuming a 100-foot radius turn or 37 kt assuming a 150-foot radius turn. Exiting the runway onto the taxiway (which was not at right angles to the runway but angled forwards by  $120^\circ$ ) would be possible with a 150-foot turn and would not require a turn radius greater than 100 feet unless the turn was initiated very late. Therefore the aircraft should have been able to sustain a turn speed of at least 30 kt before

exceeding the certification load requirements. It is also likely that the aircraft would start to skid before reaching the 0.83 g limit.

### **Analysis**

The overload failure of the downlock link was consistent with the failure that would result following a collapse of the side brace as it came out of its over-centre position. Under load, an unlocked side brace would push against the downlock link and bend the pivot bolt before eventually failing the link itself.

The Cessna 310R main gear rigging procedure is very involved and needs to be followed from start to finish. According to the manufacturer, making small adjustments to parts of the rigging can result in the gear collapsing. The threaded stud in the downlock link was adjusted to almost its minimum length, which would have provided the minimum movement against the side brace. Any slack in the system could have resulted in the side brace unlocking and the gear collapsing.

The aircraft's landing performance would have permitted the aircraft to slow down to 10 kt before the taxiway after touching down near the numbers. The aircraft may have been travelling faster than 10 kt as reported by a witness, but the extra speed should not have caused a properly rigged landing gear to collapse. It is likely that the side load during the turn in combination with a slightly out of rig left main landing gear system caused the side brace to unlock and the gear to collapse.