

## ACCIDENT

<b>Aircraft Type and Registration:</b>	Rockwell Commander 114, G-TWIZ
<b>No &amp; Type of Engines:</b>	1 Lycoming IO-540-T4B5D piston engine
<b>Year of Manufacture:</b>	1978 (Serial no: 14375)
<b>Date &amp; Time (UTC):</b>	1 August 2017 at 1243 hrs
<b>Location:</b>	Lydd Airport, Kent
<b>Type of Flight:</b>	Private
<b>Persons on Board:</b>	Crew -1                      Passengers - 1
<b>Injuries:</b>	Crew - None                      Passengers - None
<b>Nature of Damage:</b>	Left landing gear upper side-brace fractured, damage to left wing and left cabin access step
<b>Commander's Licence:</b>	Light aircraft pilot licence (LAPL)
<b>Commander's Age:</b>	79 years
<b>Commander's Flying Experience:</b>	469 hours (of which 347 were on type) Last 90 days - 1 hour Last 28 days - 1 hour
<b>Information Source:</b>	AAIB Field Investigation

## Synopsis

The aircraft's left main landing gear (MLG) leg collapsed while landing at Lydd, following the fracture of the left MLG upper side-brace during retraction of the landing gear after takeoff. The upper side-brace had fractured under the application of landing gear retraction loads, due to the presence of a fatigue crack originating at a 'cold shut' casting defect. In response to this investigation the Type Certificate holder issued Service Bulletins applicable to the Rockwell Commander 112 and 114 aircraft models requiring inspection of the upper side-brace for cracking.

## History of the flight

The commander took off from Runway 21 at Lydd Airport, with one passenger on board. During the climb the commander moved the landing gear selector lever to UP but he noted that the left MLG green light remained lit, indicating that this landing gear had not fully retracted. This situation was confirmed by Lydd Airport ATC by radio. The commander recycled the landing gear several times, but on each occasion when the landing gear was selected UP, the left mainwheel remained extended with the green light lit. When the landing gear was selected DOWN, all three landing gear green lights illuminated.

The commander decided to return to Lydd Airport and, on approach to Runway 21, ATC advised that all three landing gear legs looked down. The commander landed the aircraft normally, initially on all three wheels but as the aircraft slowed during the landing roll, the

left MLG leg folded inwards. The commander turned the fuel selector and battery master switch to OFF before the aircraft stopped, and he guided the aircraft to the grass to the left of the runway. Once the aircraft came to rest, the commander and his passenger exited the aircraft without difficulty. The aircraft sustained damage to the left wing and left cabin access step. During the recovery of the aircraft it was discovered that the left MLG upper side-brace had fractured, preventing the left landing gear leg from retracting, or locking in the extended position.



**Figure 1**

G-TWIZ following the collapse of the left MLG (photo courtesy James Giller)

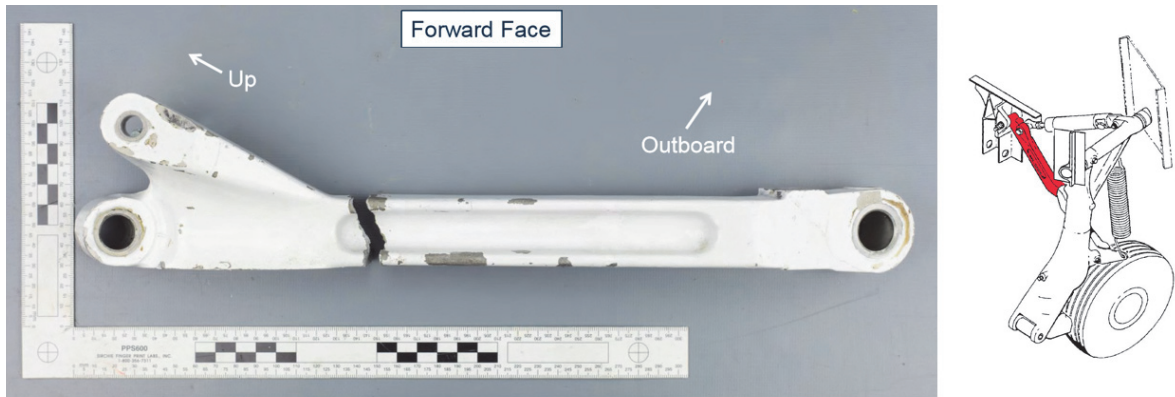
### **Aircraft information**

The aircraft was manufactured in 1978 and had accumulated 2,543 airframe hours when the accident occurred. The last maintenance inspection, a six-monthly check, was carried out on 6 April 2017. The last annual inspection was carried out on 5 October 2016 at 2,522 airframe hours. A review of the aircraft's technical records did not reveal any evidence of the left MLG side-brace having been replaced since the aircraft was manufactured.

The left and right MLG side-brace components, part numbers 45304-1 and 45304-2 respectively, are common to both the Rockwell Commander 112 and 114 aircraft models. The MLG side-brace components are manufactured from aluminium alloy using a casting process.

### **Aircraft examination**

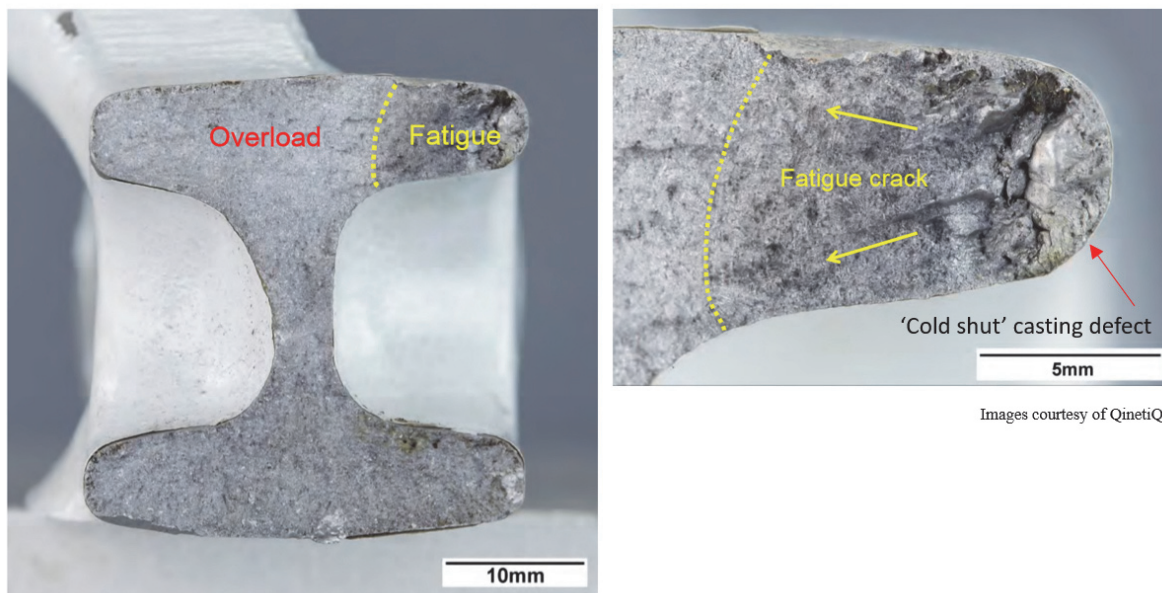
The fractured landing gear upper side-brace, part number 45304-1, was removed from the aircraft and subjected to metallurgical examination.



Images courtesy of QinetiQ and Commander Aircraft Corp.

**Figure 2**  
Fractured left MLG upper side-brace

Ink markings on the surface of the casting, beneath the external paint layer, indicated that it had been manufactured in October 1977. The metallurgical examination indicated that a fatigue crack had initiated at the location of a 'cold shut'<sup>1</sup> casting defect. The fatigue crack and casting defect extended to approximately 14% of the cross-sectional area of the side-brace section. The remainder of the fracture surface consisted of ductile overload and no crack arrest marks were observed. The metallurgical analysis also revealed the presence of additional internal and surface-breaking casting defects and sand particles within the casting, adjacent to the fracture surface.



Images courtesy of QinetiQ

**Figure 3**  
Casting defect and fatigue crack region

#### Footnote

- <sup>1</sup> A 'cold shut' casting defect occurs where a front of liquid metal within the mould solidifies prematurely during casting, leaving a weak spot in the cast component.

The upper side-brace casting drawing was supplied to the AAIB by the aircraft's Type Certificate holder, Commander Aircraft Corporation. This stated that the upper side-brace was required to be manufactured from 356-T6 aluminium alloy. Electrical conductivity measurements and qualitative energy-dispersive X-ray analysis of the elements present in the microstructure of the upper side-brace confirmed that the material was consistent with 356 aluminium alloy in the T6 heat-treatment condition. The casting drawing classified the upper side-brace casting as a 'Class 1A, Grade C' casting in accordance with the MIL-C-6021 standard 'Castings, Classification and Inspection of'. Class 1A castings must be individually inspected using radiographic (X-ray), dye penetrant and visual inspection techniques. Both the dye penetrant and radiographic inspection techniques specify that no cracks or 'cold shuts' should be present in the component.

The metallurgical examination determined that the casting defect that initiated the fatigue crack was large enough to be observed by radiographic inspection.

### **Maintenance requirements**

The aircraft Maintenance Manual, at section 6 'Landing gear, wheels and brakes', contains the requirement to visually inspect the MLG side brace links for cracks. This task is to be performed at annual maintenance inspections:

#### ***CLEANING, INSPECTION AND REPAIRS OF MAIN GEAR***

- a. Clean all parts with a suitable dry type cleaning solvent.*
- b. Inspect all bolts, bearings and bushings for excess wear, corrosion and damage*
- c. Inspect gear trunnion and side brace links for cracks, bends or damage.*

### **Previous event**

A search for previous similar events revealed only one other occurrence, involving a Rockwell Commander 114, serial number 14367, that occurred during landing in July 2004. This event was investigated by the NTSB<sup>2</sup> which determined that a MLG upper side-brace had fractured due to a fatigue crack originating at a casting defect. The Rockwell 112/114 Type Certificate holder stated that the side-brace castings were produced in batches of 50 and that after casting, a machining operation was performed on each casting to remove one of the cylinder attachment lugs to produce either a left (45304-1) or right (45304-2) side-brace component. Therefore a single casting batch produced sufficient components for 25 aircraft.

The close proximity in aircraft serial numbers between G-TWIZ (serial number 14375) and N114TS (serial number 14367) indicates that the defective side-brace components may have been produced from the same casting batch, although the Type Certificate holder could not locate the production records to confirm this hypothesis.

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#### **Footnote**

<sup>2</sup> NTSB investigation CHI04LA199; Rockwell 114 N114TS, right MLG collapse during landing at Gerald R. Ford International Airport, Grand Rapids, Michigan, USA on 28 July 2004.

A search of the FAA Service Difficulty Reporting System and the ECCAIRS<sup>3</sup> database did not reveal any further similar occurrences.

### Analysis

The left MLG side-brace fractured during the landing gear retraction process following departure from Lydd Airport, causing the left MLG leg to remain extended but not locked in the down position. The left MLG therefore collapsed during the landing at Lydd Airport.

The side brace fractured due to ductile overload, following propagation of a fatigue crack originating at a 'cold shut' casting defect. This casting defect was large enough to be detected by radiographic (X-ray) inspection and the side brace component should have been inspected using this method during the manufacturing process, as required by the component's Class 1A classification under the MIL-C-6021 standard.

This event is the second recorded incident of a MLG side brace failure due to propagation of a fatigue crack from a casting defect. It could not be confirmed whether both failed components were from the same manufacturing batch.

### Conclusion

The aircraft's left MLG leg collapsed during landing due to the fracture of the upper side-brace during retraction of the landing gear after takeoff. The upper side-brace fractured under the application of landing gear retraction loads due to the presence of a fatigue crack originating at a 'cold shut' casting defect. This casting defect was large enough to be detectable by radiographic (X-ray) inspection when the casting was manufactured and this inspection method was required according to the component's classification under MIL-C-6021. This is the second occurrence of a Rockwell Commander 114 MLG collapse due to side-brace fracture originating at a casting defect within the side-brace.

### Safety action

In response to this investigation the Type Certificate holder, Commander Aircraft Corporation, issued Service Bulletins SB-112-75 and SB-114-37, applicable to the Rockwell Commander 112 and 114 aircraft models respectively. These Service Bulletins require inspection of the upper side-brace for cracking in the area of the retraction cylinder attachment and replacement of the upper side-brace if it is found to be cracked and not repairable.

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### Footnote

<sup>3</sup> European Coordination Centre for Accident and Incident Reporting Systems.