

ACCIDENT

Aircraft Type and Registration:	Spitfire IXT, G-LFIX	
No & Type of Engines:	1 Rolls-Royce Merlin 25 piston engine	
Year of Manufacture:	1944 (Serial no: ML407)	
Date & Time (UTC):	15 September 2016 at 1520 hrs	
Location:	Sywell Aerodrome, Northampton	
Type of Flight:	Commercial Operation	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Heavy damage to propeller, minor damage to engine cowls, landing gear doors and wingtip	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	60 years	
Commander's Flying Experience:	23,500 hours (of which 500 were on type) Last 90 days - 150 hours Last 28 days - 40 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The left landing gear collapsed on the landing roll despite the pilot having selected the landing gear down and confirmed indications that it was down and locked. The aircraft subsequently left the runway and came to rest on grass beside it. The pilot and passenger vacated the aircraft uninjured.

It was subsequently discovered that the left landing gear actuator seals had failed, preventing the actuator from achieving full extension.

History of the flight

The pilot stated that he was conducting the second passenger flight in G-LFIX that day. The weather was fine with a light wind favouring Runway 03L¹. Having re-joined the circuit downwind the pilot selected the landing gear down and felt both legs lower, then observed the illuminated DOWN lights indicating the landing gear was locked down. As there was a bright sun the pilot briefly removed his sunglasses to check that indication was not in fact glare on the indicator. A normal approach to Runway 03L was then flown.

The aircraft crossed the runway threshold at about 85 kt before landing in a 3-point attitude with no bounce or yaw and initially tracked straight for about 250 m. However, at about

Footnote

¹ Runway 03L is a concrete runway with a landing distance available of 1,000 m.

35 kt the left wing started to lower. The pilot tried to counteract this with full right aileron and full rudder as the aircraft started to yaw rapidly to the left, departing the runway onto grass beside it. The pilot switched the engine's magneto switches off as the aircraft came to rest on its nose (Figure 1). The aerodrome's RFFS were quickly on the scene.

The pilot vacated the aircraft unassisted followed by the uninjured passenger with the use of a ladder provided by the RFFS.



Figure 1

G-LFIX after the landing gear collapse

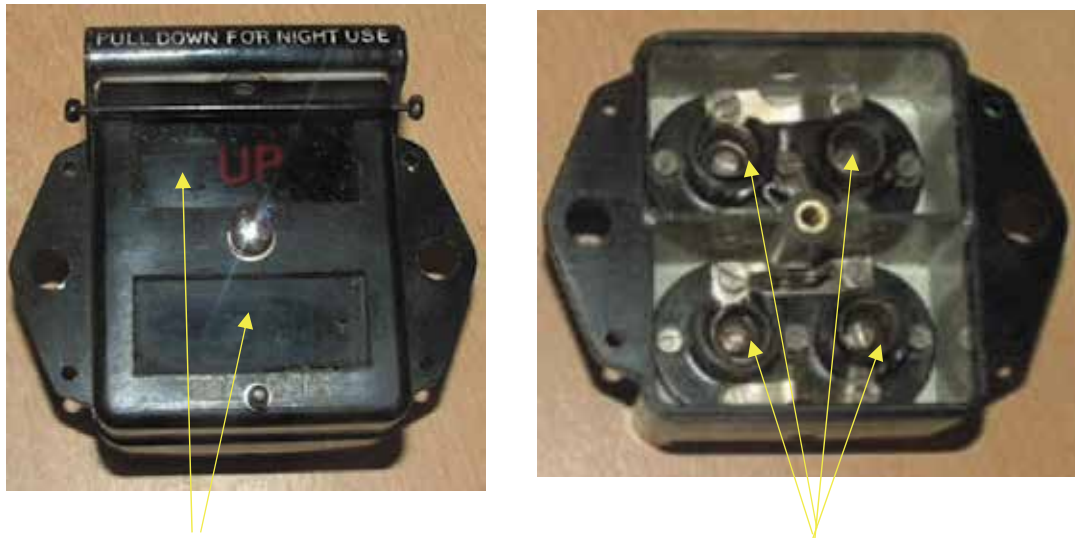
Landing gear description

The landing gear of the Spitfire Mk IX is operated by two hydraulic actuators, one for each landing gear. In both the extended and retracted position each landing gear is held in position by a spring-actuated chamfered locking pin which engages in either the down-lock lug or the up-lock lug on each landing gear.

Extension of the landing gear requires the pilot to move the selector lever out of its detent. This energises the hydraulic system and actuator, removing the load from the locking pin, and rotates the locking pin 180°. Movement of the selector lever to the DOWN detent retracts the landing gear actuator, moving the landing gear past the chamfer of the landing gear locking pin. While the landing gear is in motion DOWN appears in the landing gear status window on the landing gear selector. When each landing gear is fully extended the increase in hydraulic system pressure operates a pressure switch which causes IDLE to be displayed in the landing gear status window. In addition, when the landing gear locking pin has engaged in the down-lock lug of the landing gear, the indication circuit for that landing gear is completed.

Landing gear position indication

The Spitfire Mk IX is fitted with a landing gear position indicator on the left side of the instrument panel. The indicator consists of two black, back-illuminated panels. When the bulbs behind the panels light up the word UP is displayed in the upper panel and the word DOWN in the lower panel (Figure 2).



Indicator panel windows

Bulb positions (panel cover removed)

Figure 2

Landing gear indication panel

When both landing gear legs are locked in the down position and the respective indication circuits are made, the DOWN caption is illuminated. Two lights are fitted behind each caption to provide indication in the event of a single bulb failure.

The landing gear indication system fitted to G-LFIX had been modified so that instead of both bulbs behind the relevant caption illuminating only when both landing gear legs were in the relevant position, the left bulb in each panel would indicate the position of the left landing gear leg and the right bulb the position of the right landing gear leg. This meant that the letters 'D' and 'O' of the word DOWN in the panel would be illuminated by the left bulb and the letters 'W' and 'N' would be illuminated by the right bulb.

The operator stated that the differences between this aircraft's landing gear indicator and a conventional indicator are verbally briefed to pilots during their conversion onto the aircraft by the chief pilot.

Aircraft examination

After recovery of the aircraft by the maintenance organisation it was found that the left landing gear was difficult to force into the down and locked position. The landing gear selector was in the down position and the IDLE caption was showing in the landing gear

selector window. Further inspection revealed that the landing gear had failed to lock down because the landing gear actuator ram chevron seals had failed and pieces liberated from the seals had migrated between the actuator ram and the seal support plate, jamming the actuator ram before it reached its full extension (see Figure 3).



Seal support plate

Seal Debris

Seals

Figure 3

Seal debris on landing gear actuator ram

Each landing gear actuator is fitted with three seals. In 2013, due to a hydraulic leak, replacement seals were purchased and fitted by the maintenance organisation. As the supplier only had four new seals available, two of the original seals were refitted to the landing gear actuators. The maintenance organisation confirmed that the seals which failed were from the four purchased in 2013. The seals have an estimated life of five years.

The manufacturer of the seals was advised of the event by the aircraft's maintenance organisation, which also contacted other Spitfire operators directly to ensure they were aware of the problem. They discovered that other operators have had similar problems, but that they had not informed the seal manufacturer.

All the seals were passed to the AAIB. Examination under high powered optical microscopy confirmed that the failure of the seals had initiated in the region of the seal lip. The failure surfaces indicated that the seal lip material had been drawn between the seal and the actuator ram. Examination of the internal bore of the seals and the failure surfaces indicated that the seal failure had been progressive, with small amounts of material being liberated. The presence of this material between the seals and the hydraulic ram resulted in the release of further material which, over a number of operating cycles, produced sufficient material to jam the actuator ram within the seal pack.

Tests

Destructive and non-destructive testing was carried out on both the original and replacement (2013) seals by two independent laboratories to identify a reason for the failure of the 2013 seals. The tests did not identify a difference in either the physical properties or the chemical constituents of the seals that could have made the 2013 seals more prone to early failure.

During their investigation of the event the maintenance organisation carried out tests on the landing gear position indication system. These confirmed that the indication system was serviceable. They also showed that, in the event that the left bulb in the DOWN indicator panel did not illuminate, the indirect light produced by the bulb on the right side of the indicator was sufficient to partially illuminate the letters D and O of the DOWN indication.

Analysis

The partial collapse of the landing gear was caused by the failure of chevron seals in the left landing gear actuator, which jammed the actuator before it reached the “down and locked” position. When the actuator became jammed, the increase in pressure within the hydraulic operated the pressure switch in the landing gear selector, which resulted in the status indicator window changing from DOWN to IDLE and provided an indication to the pilot that the landing gear had completed its extension cycle. Extensive examination and material testing was unable to identify a defect within the failed seals or a change in the chemical composition of the seals purchased in 2013 that would have contributed to their failure.

No defects were found within the landing gear position indication system. The fact that the left landing gear did not achieve a locked position meant that the left light bulb in the landing gear position indicator would not have illuminated. However, tests showed that sufficient light was produced by the right bulb to illuminate the D and O of the DOWN caption.

Safety action

In order to prevent the illumination of the complete word “DOWN” in the landing gear position indicator in the event that one landing gear has not achieved the fully locked position, the maintenance organisation modified the landing gear indicator to prevent light from either of the indicator bulbs illuminating the complete DOWN caption.

Conclusion

The collapse of the left landing gear was caused by a failure of the landing gear actuator chevron seals, which jammed the actuator before the landing gear had reached the locked position.

The reason for the failure of the chevron seals purchased in 2013 could not be determined. The modification to the landing gear indicator panel should minimise the possibility of a pilot being unaware of a failure of the landing gear to achieve a locked position.