ACCIDENT

Aircraft Type and Registration:	Boeing A75L300 'Stearman', G-CGPY
No & Type of Engines:	1 Lycoming R-680-E3B piston engine
Year of Manufacture:	1945 (Serial no: 75-5303)
Date & Time (UTC):	23 June 2020 at 1420 hrs
Location:	Culmhead, Somerset
Type of Flight:	Commercial
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to wingtip and fuselage
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	17,219 hours (of which 12 were on type) Last 90 days - 9 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional enquiries by the AAIB

Synopsis

After performing several wing-walking experience flights at Chiltern Park Aerodrome, Oxfordshire, the aircraft was returning to Dunkeswell Airport, Devon, when its engine stopped producing power. The pilot performed a forced landing in a field.

The investigation revealed inconsistencies in fuel planning assumptions, and it is likely that insufficient fuel reserves were onboard for the accident flight.

The operator has taken safety action to improve fuel planning and pilot technical knowledge, and has amended its process for authorising flights.

History of the flight

Background

On the morning of the accident the pilot (Pilot A) flew G-CGPY from Dunkeswell Airport, Devon, to Chiltern Park Aerodrome, Oxfordshire. He and another pilot (Pilot B) employed by the operator would each perform a number of 'wing-walking' experience flights at Chiltern Park, before Pilot A returned the aircraft to Dunkeswell later that day.

Pilot A reported that the aircraft left Dunkeswell with a full tank of fuel[1] and while at Chiltern Park uplifted 100 litres of fuel from jerrycans[2].

The flight

Pilot A reported that on the return flight towards Dunkeswell the aircraft began to "struggle" near Culmhead disused aerodrome in Somerset, at around 2,000 ft amsl (1,100 ft agl) and with low cruise power set.

He applied carburettor heat but the engine "ran rough" and the aircraft started to descend. "Cycling" the throttle did not help and, although he anticipated the engine would "clear", it was not producing sufficient power.

Forced landing options were limited because of surrounding obstructions and the characteristically high descent rate of the Stearman with a windmilling propeller[3]. However, Pilot A performed a curved approach to a nearby grass field (Figure 1), located around 5 nm north-east of Dunkeswell.

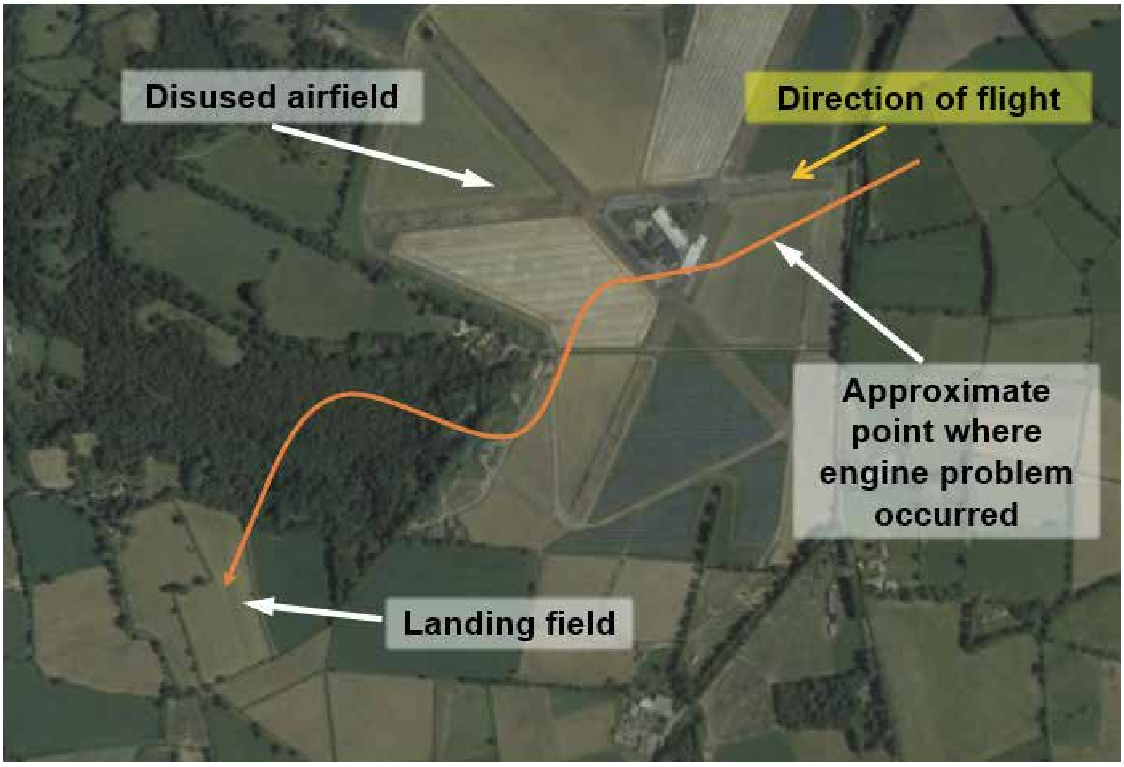

Figure 1

Approximate flight path reported by Pilot A
(© Google 2021, Image © Landsat / Copernicus" for google earth)[4]

Footnote

1 Pilot A recorded the *'Fuel* [onboard]*'* in the aircraft's technical log as *'Full'*.
2 Five cans of 20 litres each.
3 A propeller that is rotated by air flowing over the blades rather than powered by the engine, which creates significant drag.
4 Pilot A reported that at the time of the accident the aerodrome contained more obstructions than Figure 1 suggests – including a solar farm and industrial buildings.

Pilot A reported turning the magnetos off before landing, and while securing the aircraft afterwards noticed the throttle was fully open and the carburettor heat was ON. He did not report being injured but the extent of the damage to the aircraft was such that it could not be flown again until repaired.

Meteorological information

The Bristol Airport 1420 hrs METAR reported wind of 9 kt from 170°, visibility 10 km or more, no cloud detected, temperature 24°C, dewpoint[5] 14°C, and QNH 1022 hPa.

The Exeter Airport 1420 hrs METAR reported wind of 10 kt from 130°, CAVOK[6], temperature 23°C, dewpoint 14°C, and QNH 1022 hPa.

Aircraft information

General description and modifications

The Boeing Stearman is a biplane with tail-wheel landing gear. G-CPGY had been modified to perform wing walking experience flights.

The Continuing Airworthiness Management Organisation (CAMO) for the aircraft stated it had a Lycoming R-680-E3B engine installed around February 2019. The aircraft's technical log indicated it first flew with that engine in November 2019.

Fuel system

Fuel is gravity fed to the engine from a tank within the centre of the upper mainplane. There are four outlets from the tank (Figure 2). Pipes are connected to each outlet, which join forward to aft before entering the fuselage at the front supports. The left and right pipes join aft of the firewall before going to the engine as a single pipe. Fuel should therefore be available to the engine throughout the pitch and roll range provided positive g is maintained.

G-CGPY's *'Pilot's Flight Operating Instructions'* specified a fuel tank capacity of 46 USG (174 litres), and its *'Weight and Centre of Gravity Schedule'* described all of this as usable. The CAMO stated that momentary fuel starvation of the feed sumps was considered possible in some attitudes at low fuel levels.

Another operator of wing walking flights, in a Stearman with the same engine type and fuel tank as G-CGPY, reported that its aircraft's fuel tank capacity was approximately the same[7] as G-CGPY's. That operator specified an unusable[8] fuel quantity of 5.5 litres for its aircraft, indicating a usable capacity of around 167 litres.

Footnote

5 Dewpoint – the temperature at which the relative humidity of that air would reach 100%, based on its current degree of saturation.
6 Visibility ≥10 km; no CB or TCU; no cloud below 5,000 ft; and no significant weather at or near the aerodrome.
7 Placard 38 imperial gallons –approximately 173 litres.
8 Contained in the tank but not available to the engine in flight.

G-CGPY's CAMO thought the reason for the discrepancy between the two aircraft in what was considered 'usable' fuel was probably the addition of a safety margin by the other operator, in order to avoid conditions for starvation of the fuel feed sumps.

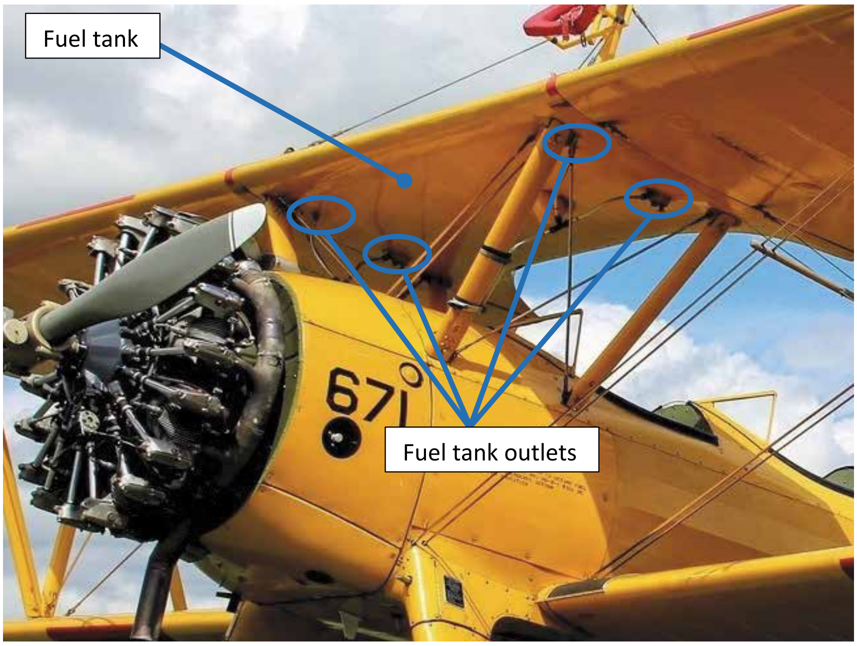

Figure 2

Fuel tank and fuel pipes from tank of G-CGPY (image used with permission)

Information from the CAMO

An engineer from the aircraft's CAMO attended G-CGPY at the accident site.

Following a subsequent inspection of the aircraft, its technical log stated that '*no mechanical reason*' was found for the engine to stop producing power.

Fuel planning information

The operator's operations manual did not contain guidance on fuel planning. Pilot A stated that he operated the aircraft according to guidance from Pilot B, and his own experience.

Fuel gauge

Pilot A reported that some time prior to the day of the accident, the aircraft's fuel gauge was "stuck on empty". There was no associated entry in the technical log. The CAMO stated that after the aircraft had been recovered "the fuel gauge in the fuel tank was found to function normally."

Regulatory information

G-CGPY was operated within the CAA's Safety Standards Acknowledgement and Consent (SSAC) framework, which allows recreational flights for fare-paying passengers in certain aircraft that are unable to meet commercial safety standards.

EASA NCO.OP.125 *'Fuel and oil supply – aeroplanes'*, applicable to the operation of G-CGPY, stated:

> *'The pilot-in-command shall only commence a flight if the aeroplane carries sufficient fuel and oil… by day, to fly to the aerodrome of intended landing and thereafter to fly for at least 30 minutes at normal cruising altitude.'*

Fuel planning information from Pilots A and B

Pilot B reported that he understood G-CGPY's fuel tank capacity to be 148 litres. He stated he had previously calculated a fuel consumption rate for G-CGPY based on having flown for 2 hours 50 minutes between two airports, which left 15 minutes of reserve fuel.

Pilot A reported that he understood G-CGPY's fuel tank capacity to be 170 litres, of which 155 litres was usable. He assumed a fuel consumption rate at cruise power of 48 to 60 litres per hour[9], and allowed 2.5 hours of endurance from a full fuel tank. For each ten-minute wing walking flight he assumed a total consumption of 15 litres.

Pilot A stated that after he and Pilot B refuelled the aircraft with all the jerrycans at Chiltern Park, the tank appeared "a few inches from full", and before departing for the accident flight appeared "approximately three quarters" full.

Pilot A stated that he drained approximately 20 litres of fuel from the aircraft's tank two days after the accident, immediately before the aircraft was recovered from the landing field.

G-CGPY's technical log included takeoff-to-landing times for each flight. Taxi times were not recorded.

Fuel planning information from the other operator

The other operator stated that it used the following fuel planning assumptions[10], based on experience of operating wing walking flights in its aircraft:

- Consumption rate at a normal cruise power setting – 65 litres per hour
- Total consumption for taxi, takeoff and climb – 15 litres
- 1 hour flight 'chock-to-chock' – 80 litres
- Total consumption for a ten-minute wing walking flight – 15 to 17 litres
- Maximum planned flight time on a full tank of fuel, allowing reserves – 2 hours[11,12]

Footnote

9 He reported using 0.8 to 1 litre per minute.
10 These assumptions did not preclude pilots using more conservative figures as required by the circumstances of the flight.
11 Using 65 l/hr average consumption, fuel remaining after a 2 hour flight would be around 44 litres or 41 minutes endurance.
12 One of its pilots stated he had never exceeded 2 hours and 15 minutes on a full tank of fuel.

Carburettor icing

The CAA's *'Safety Sense leaflet 14 Piston Engine Icing'* explains that carburettor icing:

> *'can occur at any time… It can be so severe that unless* ***correct*** *action is taken the engine may stop (especially at low power settings during descent, approach or during helicopter autorotation).'* [Emphasis in original.]

Analysis

Introduction

The total of all fuel provided for G-CGPY on the day of the accident, including a full tank and the amount uplifted, was a maximum of 274 litres, some of which may have been unusable.

Fuel planning - Pilot B

Pilot B reported calculating a fuel consumption rate for G-CGPY, based on a 2 hr 50 minute flight, at the end of which 15 minutes of reserve fuel remained. However, by assuming a smaller fuel tank capacity than that specified in the *Pilot's Flight Operating Instructions*, the consumption rate he calculated was less than the actual rate. It is not clear how he quantified the 15 minute reserve (which is less than the EASA requirement). The flight on which he based these calculations appeared to have occurred before the Lycoming R-680-E3B engine was installed on the aircraft and therefore was not reliable.

Fuel planning – Pilot A

Using Pilot A's assessments and information from the aircraft's technical log – and adding 30 litres for the taxi, takeoff and climb phases[13] of the two positioning flights – 250 litres could have been consumed up to the time of the accident. Assuming the fuel tank was filled to maximum capacity to begin with, and using Pilot A's consumption rate of 1 litre per minute, approximately 24 minutes[14] of fuel may have remained after the accident, of which he considered 15 litres (or 15 minutes at cruise power) was unusable.

Whether or not all the fuel was usable, the aircraft would, prior to reaching *'the aerodrome of intended landing'* (Dunkeswell) have been consuming the 30 minute reserve required by Part-NCO.

Fuel planning – the other operator

The other operator's fuel planning figures were more conservative than those used for G-CGPY. Using the more conservative assumptions suggested G-CGPY may have consumed up to 273 litres throughout the day, which was approximately all of the fuel that had been loaded on the aircraft.

Footnote

13 Pilot A did not specify fuel planning assumptions for these flight phases, which are dependent among other things on their duration. The figures specified by the other operator have been added to enable an estimate to be made.

14 Using the other operator's figures the calculated endurance would be approximately 22 minutes.

Discussion

Carburettor icing was a possibility, and the investigation did not exclude other technical reasons for the engine to stop producing power. Without a record of accurate measurements it was not possible for the investigation to determine the actual fuel quantities. However, the available information indicated that the aircraft's fuel tank did not contain sufficient fuel, including the required reserve, for the intended flight. When the engine stopped producing power, Pilot A's prompt actions reduced the severity of the outcome.

The pilots of G-CGPY did not appear to have a complete understanding of the usable fuel quantity and consumption rate for the aircraft. If the fuel gauge remained unserviceable as previously reported this would have exacerbated any uncertainty.

Conclusion

It is likely that the engine stopped producing power when it had consumed all the usable fuel onboard. Uncertainty about the aircraft's fuel consumption and tank capacity contributed to the circumstances.

Safety action

As a result of this accident, the operator has:

- mandated a refuel stop for its aircraft, after a maximum of 1.5 hours of flight time
- introduced a requirement for cross-country flights to depart with a full fuel tank
- introduced a requirement for its pilots to check and record an aircraft's fuel quantity every second wing walking flight using a calibrated fuel tank dipstick
- revised its aircraft technical log pages to include 'engine start' to 'engine stop' times, for accurate monitoring of fuel use and engine parameter trends
- introduced an annual technical questionnaire for its pilots, to refresh significant aspects of their safety knowledge
- introduced an SSAC Pilot Manager, in addition to the Chief Pilot role already in place, to share decision making for the operation – each post holder having equal right to prevent a flight taking place if there were safety concerns.