ACCIDENT

Aircraft Type and Registration:	Just SuperSTOL XL, G-SSXL
No & Type of Engines:	1 ULPower UL520iS piston engine
Year of Manufacture:	2016 (Serial no: LAA 397-15385)
Date & Time (UTC):	10 June 2018 at 1411 hrs (UTC)
Location:	Near Barton Aerodrome, Manchester
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Damaged beyond economical repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	76 years
Commander's Flying Experience:	9,000 hours (of which 100 were on type) Last 90 days - 100 hours Last 28 days - 65 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The aircraft was on a test flight prior to being issued with a Permit to Fly. Shortly after takeoff the engine failed. During the subsequent forced landing the aircraft landed firmly, sustaining severe damage. One of the two pilots suffered serious injuries.

It is believed that the engine failure was caused by fuel vaporisation as a result of high engine compartment temperatures.

History of the flight

The aircraft was conducting a series of test flights prior to its Permit to Fly being issued by the LAA, because it was newly built and the engine type was new to this aircraft type. Before the day of the accident, the aircraft had flown for approximately 7 hours with a different commander without event.

Before the first flight of the day, the aircraft was cleaned, and its underside was oil free. The engine's oil was checked and topped up to HALF full, as indicated on the dip stick[1]. The subsequent 20 minute flight was uneventful.

Footnote

[1] HALF on the dip stick equates to FULL (3 litres) when the aircraft is level.

The intent of the second flight was to do the required testing in the visual circuit at Barton Aerodrome. On board were a testing pilot[2], who was the commander, in the right seat and the aircraft's owner in the left. At the time, the weather was fine with a light and variable wind predominately from 200°, and the temperature was 24°C.

The aircraft took off from Runway 26 with about 8 US gal of Mogas (automotive gasoline) and the owner flying. When the aircraft was about 500 ft agl and 1 nm on the extended centreline, a warning indicated that the EGT indicated excessively hot. The engine's throttle was retarded, the aircraft turned right onto the cross-wind leg and levelled at about 800 ft agl. The engine then gradually lost power, failing shortly thereafter. The owner flew the aircraft in a right turn away from an area of woodland, with the aim of performing a forced landing in an adjacent ploughed field. The testing pilot then took control at about 200 ft agl to perform the landing.

The aircraft landed heavily, with right bank applied, and no flaps extended, resulting in the aircraft's landing gear collapsing and the aircraft coming to rest on its underside. The testing pilot suffered serious injuries and the owner minor injuries, but they were able to extract themselves from the aircraft without assistance. The testing pilot was taken to hospital in an ambulance.

When the aircraft was removed from the field, the length of the underside was very oily and had some soil stuck to it. However, there was no sign of any external oil leaks from the engine despite the oil cooler being damaged. With the engine level, the oil dip stick indicated just below minimum.

Aircraft information

The SuperSTOL XL is a high wing single engine light aircraft with side-by-side seating, designed to perform short takeoffs and landings.

Pilot Operating Handbook

The aircraft's pilot operating handbook states:

> *'**LANDING DISTANCE***
>
> *Landing distance from 50 ft. height, flaps down, throttle idle, approach speed = 60 KCAS. 450 feet.*
>
> *…*

Footnote

[2] The LAA assesses the suitability of test pilots for every flight test programme that it oversees. LAA Technical leaflet TL 1.19 provides more details and can be found here: http://www.lightaircraftassociation.co.uk/engineering/TechnicalLeaflets/Building,%20Buying%20or%20Importing/TL%201.19%20Initial%20Test%20Flying%20of%20LAA%20Aircraft.pdf [accessed April 2019]

> ***Landing with the Engine Stopped***
>
> *This airplane has no particular handling features during the landing with engine stopped and flaps up or down. Recommended speed at descent is 56 mph. Entry into flare and flare out at 1.5 feet with landing speed of 38 mph…*
> *…*
>
> ***STALL SPEEDS AT MAX TAKEOFF WEIGHT***
>
> ***Flaps up: 37 mph IAS***
> ***Flaps down: 32 mph IAS****'*

Engine operating manual

The manufacturer's operating manual for the UL520 series of engines states that the UL520iS requires a minimum of 98 octane. The section '*General operating limits'* states:

> *'**Manifold air temperature***
>
> *We advise to bring fresh air from outside the cowling to the inlet air filter/manifold*
> *Max. at start ..... 60°C (150F)*
> *Max. in flight ..... 40°C (104F)'*

The engine manufacturer commented that they advise '*bring fresh air from outside the cowling to the inlet air filter/manifold*' to try keep the inlet air temperature close to the ambient temperature.

Figure 1
Accident aircraft

Engine examination

The aircraft's air-cooled 6-cylinder engine was removed and sent to the manufacturer where its Engine Control Unit (ECU) data logger was first downloaded before the engine was examined.

Data available from the ECU was limited and did not include EGT, CHT or fuel pressure information. The data showed that the oil temperature was within limits. It also indicated that the inlet air temperature reached 76°C, though it is not known when this occurred. This high temperature indicated that the temperature inside the engine cowling was potentially high enough to affect the fuel delivery temperature and could cause a 'vapour lock'[3].

Following the accident to GJINX[4] in 2017, that had a ULPower UL 260i (4-cylinder) engine fitted, the LAA requested that fuel pressure information be recorded in the ECU. The engine manufacturer now supplies its engines with ECUs that monitor both fuel and oil pressure. The manufacturer stated that the accident engine will have this upgraded ECU fitted before it is returned to service.

The engine was then fitted to a test cell and was observed to operate normally. There were signs of an oil leak, but this was believed to be a result of the accident. It was then disassembled and no signs of overheating were observed.

The manufacturer believes that the engine failure was likely to have been caused by fuel vaporisation, due to high engine compartment temperatures resulting in a 'vapour lock'.

LAA's comments

In the absence of any other clear indications, the LAA "broadly agreed" with the engine manufacturer's diagnosis of the most likely cause of the engine failure. It has asked the engine manufacturer what the implications of an excessive inlet air temperature may be, so it can optimise its advice for future test programmes.

The LAA has received feedback from the engine manufacturer indicating that high engine inlet temperatures would not in themselves cause an engine shut down (for example by the ECU taking self-preservation action when sensing an over temperature) and the only direct consequence would be a slight loss in engine performance due to reduced inlet air density. However, a high inlet temperature would imply high engine compartment temperatures, which would tend to encourage vapour lock.

After the accident, the LAA conducted a test flight to check whether the flight manual's stated speed of 56 mph, for a landing with the engine stopped, is appropriate. Initial results suggest that that the minimum IAS to successfully flare the aircraft should be approximately 67 mph.

Footnote

[3] If fuel turns to vapour in the aircraft fuel system, large bubbles can form at high points within the fuel system, or in a constriction in the fuel pipe, which can prevent the passage of fuel to the engine. This phenomenon is known as 'vapour lock' and the effect can be a 'dead-cut' of the engine.

[4] The AAIB report on the accident involving G-JINX can be found here: https://assets.publishing.service.gov.uk/media/5ad7020fed915d32a3a70c72/Silence_Twister_G-JINX_05-18.pdf [accessed April 2019]

Pilot's comments

The owner believes that the aircraft landed firmly because it was too slow and stalled at about 20 ft.

Other events

Since 2003 the AAIB has identified vapour lock as a possible cause in nine accidents involving aircraft using Mogas. The most recent involved a Rutan Long-Ez (Modified), G-BPWP[5].

Discussion

Having had an excessive EGT warning, followed by an engine failure at about 800 ft agl, the pilots were left with little time in which to execute a forced landing in an area with limited landing options available. The testing pilot elected to take control at about 200 ft agl and perform a forced landing. Given he took control with little height available it is likely he did not stabilize the aircraft's IAS, became slow and, with no height in which to lower the nose to correct the IAS, the aircraft stalled, resulting in a firm landing.

The ECU recorded an air inlet temperature in excess of the maximum permitted in-flight temperature, and the ambient temperature was in excess of the LAA's maximum operating temperature for Mogas. The engine manufacturer and LAA concluded the most likely cause of the failure was a fuel vapour lock.

Safety actions

In consultation with the engine manufacturer, the owner stated he would have the engine cowlings redesigned to increase the intake airflow and modify the engine layout by relocating the fuel pumps and cooling fuel returning to the header tank. These changes are intended to reduce the possibility of a fuel vapour lock recurring.

LAA Technical Leaflet TL 2.26[6] highlights the procedures for using unleaded Mogas in piston engines. Due to the greater risk of vapour lock the LAA has stated that when using Mogas the temperature of fuel in the tank must not exceeding 20°C and the aircraft must fly below 6,000 ft.

The LAA plans further flight tests over a range of weights to gain more accurate approach speed data for this aircraft type.

Footnote

[5] G-BPWP's accident report can be found here: https://assets.publishing.service.gov.uk/media/5c3e05b040f0b67c6c8d082e/Rutan_Long-Ez__Modified__G-BPWP_02-19.pdf [accessed April 2019]

[6] LAA leaflet TL 2.26 can be found here: https://www.lightaircraftassociation.co.uk/engineering/TechnicalLeaflets/Operating%20An%20Aircraft/TL%202.26%20Procedure%20for%20using%20E5%20Unleaded%20Mogas.pdf [accessed April 2019]

The LAA has stated that it will review how it manages the testing of new engine types and engine installations. One option being considered is the download of the ECU's data as part of the engine's initial testing, so that all available measured parameters can be checked against the manufacturer's stated limitations.