ACCIDENT

Aircraft Type and Registration:	Reims Cessna F152, G-BLJO	
No & Type of Engines:	1 Lycoming O-235-L2C piston engine	
Year of Manufacture:	1979 (Serial no: 1627)	
Date & Time (UTC):	2 January 2023 at 1230 hrs	
Location:	Field about 1.5 nm north-east of Shoreham Airport, West Sussex	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Nose landing gear leg collapsed and damage to bulkhead	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	28 years	
Commander's Flying Experience:	89 hours (of which 17 were on type) Last 90 days - 13 hours Last 28 days - 5 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

Synopsis

While on late downwind the engine started coughing and losing power. The pilot carried out some checks, but the engine subsequently lost all power. He picked a field and glided to it but touched down nosewheel first causing the nose landing gear leg to collapse. The pilot had recently practised forced landings with an instructor and this likely contributed to the safe outcome. An aircraft examination did not reveal any faults, and the conditions were conducive to serious carburettor icing at any power, but the cause of the loss of power could not be determined.

History of the flight

The pilot was carrying out circuit practice at Shoreham Airport using Runway 20. He had carried out four uneventful circuits with 'touch-and-go' landings, and then while late downwind on his fifth circuit, at about 1,100 ft aal, he reported that the engine started coughing and losing power. He pumped the throttle, checked the magnetos were on and that the mixture was rich. He could not recall if the carburettor heat was on or if he selected it on.

The engine subsequently lost all power. He made a MAYDAY call and looked for potential landing sites as he did not think he could make it back to the runway. He found a field to the north-east and headed towards it. He set two stages of flap, and once closer he set full flap, but he did not recall doing any shutdown checks. The aircraft touched down "fairly

flat" but nosewheel first, causing the aircraft to bounce and the nose landing gear leg to collapse. The aircraft came to rest on its nose (Figure 1). The pilot exited the aircraft and was not injured.

The pilot stated that he did not know what had caused the power loss and that he had done the same thing on each of the previous four circuits, such as his downwind checks which included checking that the mixture was rich and selecting the carburettor heat on for 10 seconds. He said he had practised forced landings with an instructor the week before, and this enabled him to go into "autopilot mode" with picking a field and setting up an approach. He thinks he flared a bit too early with the downhill slope which contributed to the nosewheel-first touchdown.

The pilot stated that since the accident he has practised more forced landings.

Figure 1
Accident site

Aircraft examination

The maintenance organisation carried out an initial examination at the accident site the day after the accident. They stated that there was nearly full fuel onboard. The spark plugs looked normal, and the crankshaft could be rotated with the plugs removed. There was no evidence of oil leaks. The fuel hose was disconnected from the carburettor and fuel flowed freely. Fuel tank drain checks revealed a few droplets of water from the left tank and no water from the right tank. Both magnetos were secure with no evidence of slippage.

After the aircraft was recovered from the field the maintenance organisation removed the air intake assembly and carburettor. The carburettor heat valve operated normally and actuating the throttle mechanism caused fuel to be ejected from the fuel jet. The carburettor was then installed on another engine and the engine ran normally.

At the time of writing the engine core has been removed from service and will be sent for overhaul at some stage.

During the aircraft's last annual maintenance check in September 2022, about 100 flying hours before the accident, the engine had a top overhaul. The engine had accumulated over 2,500 hours since its last complete overhaul when the engine manufacturer's recommended time between overhaul (TBO) is 2,400 hours. The operator was operating the engine beyond the TBO by using an engine extension programme as defined in their risk assessment RA47 which involved more detailed checks and inspections; this had been approved by the CAA as part of their approved maintenance programme.

Meteorology

Ten minutes before the accident, the METAR at Shoreham Airport stated that the wind was from 250° at 9 kt, the visibility was more than 10 km, the clouds were few at 1,500 feet and scattered at 1,900 feet, with a temperature of 9°C and a dewpoint of 6°C; this meant the relative humidity at the airport was 81%. At the circuit height of 1,100 ft aal the temperature would have been about 2°C colder[1], so the relative humidity would have been closer to about 93%.

According to the CAA's risk of carburettor icing chart, in the Safety Sense Leaflet on Piston Engine Icing[2], the temperature and dewpoint spread at the airport elevation indicated that there was a serious risk of carburettor icing at any power setting (Figure 2).

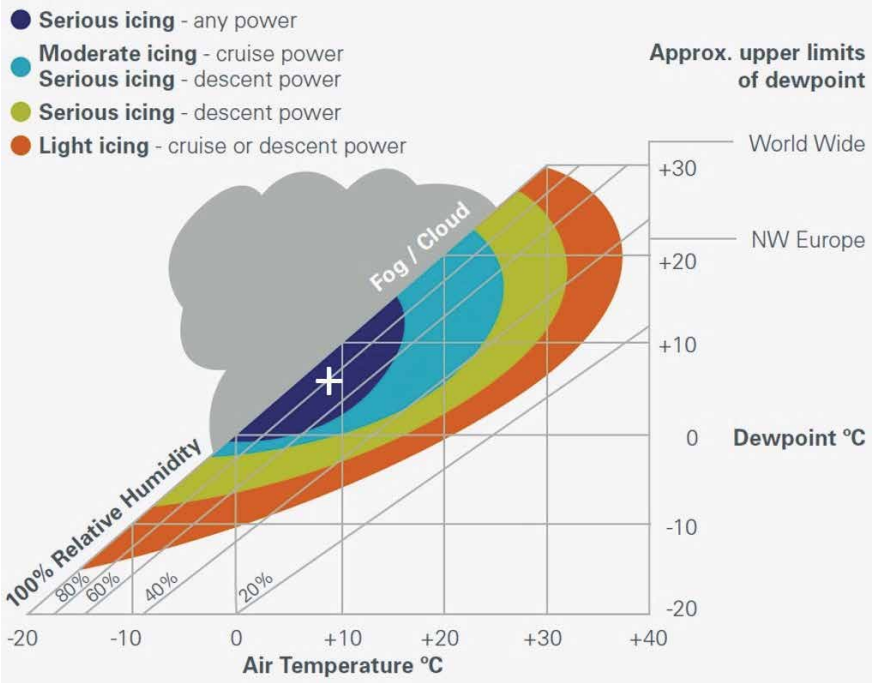

Figure 2

Temperature and dewpoint, at Shoreham Airport near the time of the accident, marked with a white cross on the CAA's risk of carburettor icing chart

Footnote

[1] The standard lapse rate in the International Standard Atmosphere (ISA) is 2°C/1,000 ft. The actual lapse rate on the day could have been different.

[2] CAA Safety Sense Leaflet on Piston Engine Icing, June 2023, [accessed October 2023].

Pilot's training history

The pilot had learnt to fly in California and after 54 hours of training in a Piper PA-28, during July and August 2018, he passed his skills test and obtained his Private Pilot's Licence with an SEP rating that was valid for two years until 31 August 2020.

After flying once in the UK in 2019, he flew on 15 occasions in 2020 and 2021 from Redhill Aerodrome in both a Piper PA-28 and a Cessna 152. He then did not fly for over a year before starting to fly at Shoreham on 18 November 2022. He needed five flights with an instructor, one in the Cessna 152 and four in a PA-28, before he was cleared to fly solo. The instructor reported that he flew well but had issues with his checks and would sometimes forget to turn the carburettor heat on when on downwind. He reported that after the training flights his checks were good, so he signed him off.

The instructor's understanding was that he had cleared the pilot to fly the PA-28, but the pilot understood that he was cleared to fly the PA-28 and the Cessna 152. The paperwork the instructor had signed stated '*ready to fly solo'* without specifying a type.

Neither the flying school nor the instructor had checked the pilot's licence which showed that his SEP rating had expired on 31 August 2020. The pilot reported that he was unaware that his rating had expired. There is no CAA system for reminding pilots when their ratings are due to expire[3]. In the year leading up to 31 August 2020 the pilot had flown more than 12 hours and had flown more than one hour with an instructor, so he had met the requirements for rating revalidation but had not obtained the required signature in his licence. The pilot subsequently obtained a new SEP rating on 18 January 2023.

The pilot flew a PA-28 solo from Shoreham on 16 and 20 December 2022, and then a PA-28 with an instructor at Redhill. On the day of the accident the pilot had booked to fly the Cessna 152 solo from Shoreham. The flying school's booking system allowed the pilot to book this aircraft despite the flying school being of the view that he was not cleared to fly the Cessna 152 solo.

The flying school has updated its electronic booking system to show in red any pilot who is out of currency or not checked out when they try to book an aircraft. Pilots' licence and rating validities are now checked by admin staff and daily checks are carried out by a flight instructor.

Aircraft flight manual

The flight manual[4] for the aircraft states the following procedure for an engine failure during flight:

'1. Glide Speed – 111 km/h – 60 kts – 69 MPH IAS.

2. Carburetor Heat – "ON".

Footnote

[3] Unlike with driving where the UK's Driver and Vehicle Licensing Agency (DVLA) reminds drivers when their driving licence is about to expire.

[4] Aircraft Flight Manual Reims/Cessna F152, D1170-13GB, serial number F15201429 and up.

3. *Primer – IN and LOCKED.*
4. *Fuel Shutoff Valve – "ON".*
5. *Mixture – RICH.*
6. *Ignition Switch – "BOTH" (or "START" if propeller stopped).'*

It also contains a procedure for 'Rough Engine Operation or Loss of Power'; this states that a gradual loss of engine rpm and engine roughness may result from carburettor ice and that to clear the ice full throttle should be applied and the carburettor heat knob pulled fully out. It states that engine roughness can also be caused by spark plug fouling or a magneto issue, and the magneto switch should be momentarily moved to the left and right position to help diagnosis.

Use of carburettor heat in the circuit

The flight manual's 'Before Landing' checklist states '*Carburetor Heat – "ON" (apply full heat before reducing power)*.' The 'Balked Landing' checklist starts with: '*1. Throttle – FULL OPEN, 2. Carburetor Heat – COLD.*'

When flying a circuit, the 'Before Landing' checklist is carried out on the downwind leg; therefore, following the flight manual's checklist would involve selecting the carburettor heat ON when on downwind and then leaving it on until landing, unless a 'balked landing' (goaround) is performed.

The pilot's instructor at Shoreham had taught the pilot to use the same carburettor heat technique on both the PA-28 and the Cessna 152. The flight manual for the Piper PA-28-161[5] states in the 'Descent' checklist '*Carburetor heat…ON if required*'. It does not have a checklist for a balked landing or go-around.

The instructor had taught the pilot to select carburettor heat on for 10 seconds on downwind, to check for the presence of carburettor ice, and then to turn it off if no ice is present. The presence of ice is established by noting any increase in engine rpm which can result after the ice has melted although some rough running can also occur when heat is first applied and ice is present. The instructor taught the pilot to turn carburettor heat on again prior to reducing power on the base leg, and then to turn it off when cleared to land on final - that is four actuations of the carburettor heat knob during each circuit. He said that some of their instructors teach to land the Cessna 152 with the carburettor heat on and then to turn it off during a touch-and-go, because their belief is that the power loss from the carburettor heat in the Cessna 152 is less than on the PA-28.

Other instructors are known to teach students to turn the carburettor heat on while on downwind and then to leave it on until final or until doing a go-around or touch-and-go.

Footnote

[5] Pilot's Operating Handbook, Piper Cherokee Warrior II, PA-28-161. VB-880. Revision 25 April 2005.

The CAA's Safety Sense Leaflet on *Piston Engine Icing* states the following:

> *'Landing*
>
> *When conducting 'downwind' or 'joining' checks prior to landing, select the carburettor heat on to remove any ice that may be present. It should be selected to hot before power is reduced on base leg or final approach. In many aircraft it is recommended to select the carburettor heat to cold again at around 300 ft, to give improved power in the event of a go-around or touch and go. The carburettor heat should be selected cold after landing if this was not already done on final.*
>
> *Go-around or touch and go*
>
> *If the carburettor heat is still in the hot position, ideally it should be moved to cold, prior to the application of take-off or go-around power. Check after applying power that you have remembered to do so. This is to ensure the engine is developing full power for the manoeuvre.'*

The safety sense leaflet includes the following caveat: '*The Aircraft Flight Manual (AFM) or Pilot's Operating Handbook is the primary source of information for individual aircraft. In the case of a conflict between the guidance in this SSL and the applicable AFM, the latter shall take precedence'.*

The PA-28 types the pilot had been flying and the Cessna 152 use a carburetted Lycoming engine. The engine manufacturer has published a Service Instruction concerning 'Use of Carburettor Heat Control'[6]. It states that 'Full Heat' should be applied during landing approach if icing conditions are suspected. It also states that: '*In the case that full power needs to be applied under these conditions, as for an aborted landing, return the carburetor to "Full Cold" after full power application*.' This is different to what is recommended in the CAA's safety sense leaflet which states to move it to 'cold' before power application.

Analysis

The relatively low-hours pilot experienced a complete loss of engine power at about 1,100 ft aal in the circuit but was able to select a field, maintain control and land. The aircraft suffered some damage, but the pilot was uninjured. The pilot had recently practised forced landings with an instructor and this likely contributed to the safe outcome.

The maintenance organisation's examinations did not reveal any faults with the engine or fuel systems and there was sufficient fuel onboard. A few droplets of water were recovered from the left fuel tank, but this was a day after the accident so could have been the result of condensation. Water in the fuel tanks usually affects engine performance shortly after takeoff, but in this event the pilot had completed four circuits, so it is unlikely that water was a factor.

Footnote

[6] Lycoming Service Instruction No. 1148C, published 12 October 2007.

According to the CAA's chart on the risk of carburettor icing, the conditions on the ground were conducive to carburettor icing at any power setting. There was a cloud layer 400 feet above circuit height so the relative humidity would have been higher at circuit height than at ground level. It is possible that the pilot forgot to select carburettor heat on downwind or did not set it for long enough. This could have led to carburettor ice formation and the coughing symptoms reported. The flight manual's 'rough engine operation' checklist calls for full carburettor heat to be selected. The pilot could not recall if it was still set or if he set it. He recalled pumping the throttle which is not a procedure in the flight manual for 'rough engine operation' or for an engine failure. Pulling the throttle back to idle, during pumping, could exacerbate a carburettor icing condition. The flight manual calls for full power to be set. It also states to check each magneto, which the pilot did not attempt, but he was at a very low height where the priority is to select a safe place to land and maintain control of the aircraft.

The pilot had been taught to select carburettor heat on while on downwind, then off after 10 seconds, then on again on base, and then off again on final once cleared to land. That is four selections of the carburettor heat knob which could increase the opportunity for one of these selections to be missed. The flight manual does not include a pre-landing check that involves selecting carburettor heat on for 10 seconds; it states to select carburettor heat on, and then leave it on until landing or a 'balked landing'. Flying a downwind leg with the carburettor heat off could contribute to carburettor ice formation.

Carburettor icing is a possible cause of the loss of power experienced, but it is also possible that the pilot made an incorrect fuel system or engine control selection because this was only his second flight in a Cessna 152 in over a year. The flying school stated that the pilot had not been approved to fly the Cessna 152 solo, but this was not clear to the pilot and the booking system did not prevent him booking that aircraft type. The booking system has been modified to prevent this in future.

The engine core has not yet been examined so an engine fault cannot be entirely ruled out.

Conclusion

The engine lost power late downwind in the circuit. The maintenance organisation's engine and fuel system examinations did not reveal any faults, although the engine core had yet to be examined. The conditions were conducive to carburettor icing at any power, so this was a possible cause, but no conclusive cause could be determined. The pilot had recently practised forced landings with an instructor and this likely contributed to the safe outcome.

Safety actions

The flying school has updated its electronic booking system to show in red any pilot who is out of currency or not checked out when they try to book an aircraft. Pilots' licence and rating validities are now checked by admin staff and daily checks are carried out by a flight instructor.