Cessna F152, G-BIJX

AAIB Bulletin No: 5/2004	Ref: EW/C2003/07/10	Category: 1.3
Aircraft Type and Registration:	Cessna F152, G-BIJX	
No & Type of Engines:	1 Lycoming O-235-L2C piston engine	
Year of Manufacture:	1981	
Date & Time (UTC):	1 July 2003 at 1218 hrs	
Location:	Headcorn Aerodrome, Kent	
Type of Flight:	Training	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Leading edges of wings bent and torn, nose gear bent, tail detached	
Commander's Licence:	Commercial Pilot's Licence with Instructor Rating	
Commander's Age:	43 years	
Commander's Flying Experience:	1,037 hours (of which approximately 900 were on type)	
	Last 90 days - 175 hours	
	Last 28 days - 52 hours	
Information Source:	AAIB Field Investigation supported by an Aircraft Accident Report Form submitted by the commander	

History of the flight

The instructor and her student were on a training flight from Lydd to Headcorn. The student who had accumulated 36 hours was the handling pilot and the intention was to do a touch and go at Headcorn and then return to Lydd. The engine power checks at Lydd were normal and the acceleration during takeoff was also reported as normal. During the cruise, at an altitude no higher than 2,100 feet, they observed some showers in the area and applied carburettor heat several times as a precautionary measure. After a direct join to the downwind leg at Headcorn, the student applied carburettor heat for approximately 10 seconds and then set it back to COLD. On base leg the student re-applied carburettor heat and reduced the power to 1,700 RPM to begin a descent. The aircraft was lined-up on finals for an approach to Runway 29 (grass) with full flap (30°) at 65 KIAS. At approximately 200 feet agl the student set the carburettor heat back to COLD.

The instructor reported that the final approach was stable and she estimated that the aircraft touched down 30 feet beyond the runway threshold marker boards. During the landing roll the instructor reduced the flap setting to 10° and visually checked that the flaps had been retracted to this position. She then realised that the aircraft was not accelerating normally and called to the student "Full power! Full power!" She then placed her hand on the throttle, over the student's hand, and confirmed that the throttle was set to full power. She glanced at the RPM gauge, which was indicating approximately 2,100 RPM. The aircraft was still not accelerating normally and the airspeed indicator was rising slowly. At approximately 40 to 45 KIAS the instructor took control and aborted the takeoff because she did not believe the aircraft would gain sufficient speed to clear the hedge at the end of the runway. She closed the throttle, pulled the yoke aft and applied the wheel brakes. At this point she estimated the aircraft had used up more than two thirds of the runway length (landing distance available was 796 metres). The braking action was not very effective and the instructor believed that they were probably skidding on the short wet grass. The aircraft ran off the end of the runway and penetrated a hedge approximately 180 metres from the runway threshold. It came to a rest on a country road on the other side of the hedge. Both pilots had been wearing lap and diagonal harnesses and were able to exit the aircraft unaided and uninjured.

Aircraft Examination

Photographs taken at the accident site indicated that the aircraft had sustained damage primarily to the wing leading edges and the tail. The vertical tail and horizontal stabiliser had separated from the fuselage but were still attached to the aircraft by control cables. The cabin environment was virtually intact. The engine was examined by the aircraft's maintenance organisation and no faults were found that might explain a power loss. The carburettor was removed and attached to another engine and then test run - the engine ran normally.

Weather

The wind at the time of the accident was reported by the instructor as light and variable. An aftercast issued by the Meteorological Office estimated that the surface conditions near Headcorn at the time of the accident were as follows: wind 260° at 13 kt, temperature 15.5°C, dew point 14.3°C and humidity 93%. The cloud estimate was: few/scattered cumulus base at 2,000 to 2,500 feet, deteriorating in showers and thunderstorms to broken cumulonimbus or large cumulus with a base of 1,500 to 2,000 feet. Some heavy rain had fallen at Headcorn Aerodrome before the aircraft had arrived.

Advice on use of carburettor heat

In the CAA Aeronautical Information Circular (AIC) 145/1997 (Pink 161) (published in LASORS 2003) the following advice is given on the use of carburettor heat:

> **Downwind**: *Include a check of the carburettor heat in the pre-landing checks and observe the reduction and subsequent increase in manifold pressure and/or RPM.*
>
> **Base Leg and Finals**: *Unless stated to the contrary in the Pilot's Operating Handbook or Flight Manual the HOT position should be selected on base leg as the power is reduced for the approach. On some engine installations, to ensure better engine response and to permit a go-around to be initiated without delay, it is recommended that the carburettor heat should be selected to COLD at about 200/300 ft on finals.*
>
> **Go-Around or Touch and Go**: *If the carburettor heat has not been selected to COLD on finals this should be done concurrently with the application of go-around power, or as shortly thereafter as is possible.*

LASORS 2003 also includes a copy of the Safety Sense Leaflet 14A on piston engine icing. The advice in the safety sense leaflet is the same as in the AIC for *'Base Leg and Finals'* and for *'Go-Around or Touch and Go'* but the advice for *'Downwind'* is amplified as follows:

- Note the RPM/Manifold Pressure

- Apply Full Carb heat for about 15 seconds and note the reduced indication.

- Return Carb heat to Cold. The RPM/Manifold Pressure will return to the earlier indication if there was no icing. If it is higher - icing was present.

The Cessna 152 Information Manual provides different advice on the use of carburettor heat during an approach. The 'Before Landing' checklist states: *'Carburettor Heat - ON (apply full heat before reducing power)'*. It does not specify a carburettor heat check on the downwind leg and it does not specify a check to turn the carburettor heat off before touchdown. In the event of a go-around it states that full power should be selected before turning the carburettor heat off.

Analysis

According to the Cessna 152 Information Manual the normal static engine RPM is 2,280 to 2,380. Following the accident the instructor conducted a test on another Cessna 152 and noted that the engine RPM was 2,400 at an airspeed of approximately 30 kt. The indicated reading of 2,100 RPM during the touch and go therefore shows that the engine was not performing normally. The thrust from a fixed pitch propeller is proportional to the square of the RPM. A reduction in RPM from 2,400 to 2,100 at the same airspeed would result in a 23% reduction in thrust. This reduction in thrust could in itself be responsible for the sluggish acceleration during the touch and go. The wet grass would also have had some effect on reducing the aircraft's acceleration.

The engine examination by the maintenance organisation did not reveal a fault that would explain the low RPM during the touch-and-go. The engine operated normally during the takeoff from Lydd and therefore the possibility of carburettor icing at Headcorn must be considered. The temperature and high humidity at the time of the accident placed the risk of carburettor icing in the highest of the four regions on the carburettor icing chart in CAA Aeronautical Information Circular 145/1997 (Pink 161). The chart indicates that there was a serious risk of carburettor icing at any power setting without carburettor hot air selected. Carburettor hot air was selected for 10 seconds on downwind and then it was reapplied for a period of approximately 1 minute and 40 seconds[1] whilst descending on base leg and finals to 200 feet agl at low power. At 200 feet carburettor hot air was selected COLD. This procedure was not in accordance with the specific procedure in the Cessna 152 Information Manual but it was in close accordance with the generalised advice from the CAA. The CAA advises that where such conflicts occur, the flight manual takes precedence.

The effectiveness of carburettor heat is reduced at low power settings and so it is possible that some carburettor ice formed during the descent. The condition could then have worsened when carburettor heat was turned off at 200 feet. Alternatively, all the ice may have formed during the final 200 feet to land and on the runway during the ground roll but the AAIB could not find any research evidence to support or reject such a theory. It is not known how quickly carburettor ice can form.

After the power loss was recognised and the takeoff was aborted, the aircraft failed to stop in the remaining runway length. However, although the takeoff was aborted with less than a third of the 796 metre runway remaining, the landing performance charts in the flight manual indicate that on a dry grass runway the aircraft should have stopped well within this distance (210 metres to decelerate from 54 kt). The instructor reported that on the day of the accident the grass was wet and "very short". The CAA's Safety Sense Leaflet on Aeroplane Performance states that the landing distance from a height

[1] After the accident the instructor re-flew the same circuit and timed how long the carburettor heat would probably have been on for during the descent from base leg to 200 feet agl on final.

of 50 feet should be increased by 30% when the grass is wet and up to 20 cm in length. It then states that when *"the grass is [wet and] very short, the surface may be slippery and distances may increase by up to 60%"*. The short wet grass explains why the braking action was poor and this factor was probably the direct cause for the runway over-run.

Conclusions

When calculating takeoff performance, consideration should also be given to stopping performance in the event of a problem developing during the takeoff that may require an abort. These calculations are particularly important when normal safety margins are reduced such as when operating from wet grass runways.

A contributing factor to this accident was the lack of acceleration during the take-off roll. The wet grass would have had some effect on reducing the acceleration but the reported loss of normal RPM would have had a greater effect. The reason for the RPM loss could not be established but carburettor icing appeared to be the most likely explanation. The atmospheric conditions were conducive to the formation of carburettor ice but it is not known how quickly carburettor ice can form and it is not known how effective carburettor heat is at low power settings. It is therefore recommended that:

Safety Recommendation 2004-01

The CAA should sponsor or conduct research to determine:

a. How readily carburettor ice can form at low power settings with carburettor heat ON;

b. How quickly carburettor ice can form when carburettor heat is OFF;

c. Whether the Authority's advice on the use of carburettor heat during an approach to land should be revised in the light of its research findings.

Safety action pending

Commencing in 2004 the CAA intends to conduct research on carburettor ice formation in co-operation with Loughborough University.