

## ACCIDENT

<b>Aircraft Type and Registration:</b>	Reims Cessna F150M, G-BDZC
<b>No &amp; Type of Engines:</b>	1 Continental Motors Corp O-200-A piston engine
<b>Year of Manufacture:</b>	1976 (Serial no: 1316)
<b>Date &amp; Time (UTC):</b>	17 October 2016 at 1021 hrs
<b>Location:</b>	Bourn Airfield, Cambridgeshire
<b>Type of Flight:</b>	Private
<b>Persons on Board:</b>	Crew - 1                      Passengers - 1
<b>Injuries:</b>	Crew - 1 (Fatal)    Passengers - 1 (Serious)
<b>Nature of Damage:</b>	Aircraft destroyed
<b>Commander's Licence:</b>	Private Pilot's Licence (A)
<b>Commander's Age:</b>	58 years
<b>Commander's Flying Experience:</b>	363 hours (of which 9 were on type) Last 90 days - 7 hours Last 28 days - 2 hours
<b>Information Source:</b>	AAIB Field Investigation

## Synopsis

The aircraft was seen to take off with 40° flap set. It did not appear to climb and flew at low level above the runway. Approaching a line of trees beyond the end of the runway, the nose pitched up and the aircraft banked left. The left wing dropped and the aircraft descended in a steep nose-down attitude into the ground. The pilot was fatally injured but the passenger survived. The investigation concluded that the pilot had attempted to take off with the flaps unintentionally set to the fully deployed position. The excess drag in this condition prevented the aircraft from climbing.

## History of the flight

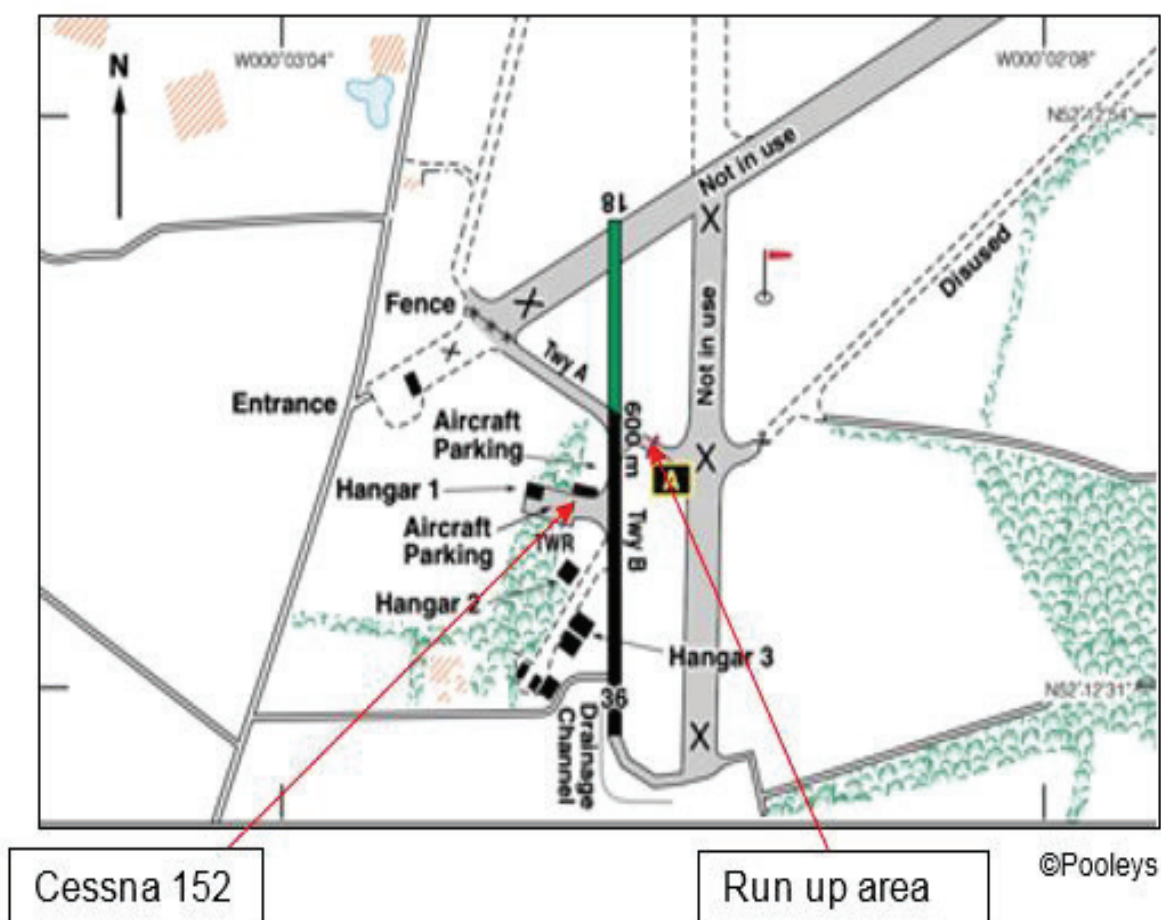
The pilot started flying at Bourn Airfield in April 2016. He was not familiar with the Cessna aircraft which were available at the flying club so during the next few weeks he was checked out by an instructor, flying in both a Cessna 150 (C150) and a Cessna 152 (C152). He completed 4 hours of dual training, a proficiency check, twenty minutes of solo flight and several subsequent flights, including a land away, accompanied by the same instructor.

On 17 October the pilot planned to take his father-in-law for a flight from Bourn to Enstone, Oxfordshire, and then return. There were two aircraft available for hire at the club. At the time he booked he had stated a preference for the C150 G-BDZC; the instructor thought this may have been because he had previously experienced the seat slipping back unexpectedly in the C152.

The pilot and his passenger arrived at the airfield mid-morning. Another club member was

already there; he had opened up the club house and was planning to fly the club C152 with an instructor. He carried out a pre-flight inspection and refuelled the C152 before assisting the accident pilot with refuelling G-BDZC; he noted that both tanks were refuelled to just below the filler cap. The pilot's own pre-flight inspection was partly observed by the other club member, who noticed that the flaps were deployed for the walkround.

The pilot, with his passenger on board, started the engine and taxied from behind the C152 across to the run-up area, located on an old taxiway to the east of Runway 18 (Figure 1). He remained there a short while and then taxied towards the threshold of Runway 18, out of view of the occupants of the C152.



**Figure 1**

Aircraft parking and run-up areas at Bourn Airfield

The pilot broadcast a radio call to say that he was 'rolling' and the occupants of the C152 then saw the aircraft airborne, just above the runway, but not apparently climbing. They realised, as it passed in front of them, that the flaps were fully deployed. The instructor attempted to make a radio call to warn the pilot, but it was too late to be effective and there was no response. They watched G-BDZC continue towards a line of trees beyond the end of the runway and then saw the nose pitch up and the start of a left turn. The left wing then dropped and the aircraft appeared to enter an incipient spin, descending quickly to the ground.

Several people from the flying club and personnel from an industrial site on the airfield ran across to the aircraft. They were able to assist the passenger from the aircraft, but the pilot was trapped. Attempts were made to turn off the aircraft electrical power but it remained on, and, because of the potential fire risk, it was decided to attempt to get the pilot out. He was unconscious but they released him from the aircraft and pulled him clear. Cardiopulmonary resuscitation (CPR) was administered but they were not able to sustain his breathing. Emergency services arrived at the scene and a paramedic continued to attempt to resuscitate the pilot but without success.

### Accident site

The aircraft had come to rest against some trees located on the southern boundary of the airfield (Figure 2). The accident site was some metres to the left of the extended centreline of the runway.



**Figure 2**

View of airfield showing accident site location relative to the extended centreline of the runway (red line). The 'old', disused runway is visible to the right.

The aircraft had taken off from the repositioned Runway 18, which had been brought into use during the spring of 2016. This was the result of the landowner leasing the old runway to a company that used it for storing ISO containers. The new runway utilised the old taxiway and had a grass extension to the north, giving a total length of 600 m.

The trees on the southern boundary ran in an approximately east-west direction and had a gap in line with the old runway. The aircraft had come to rest in a steep, nose-down attitude against the trees at the western edge of the gap. The trees were up to about 40 ft high and

it was apparent that, apart from some light branches and foliage having become dislodged, there had not been a severe impact from the aircraft. Marks on the ground close to the base of the trees indicated that the aircraft had struck the ground in a near vertical attitude on its nose and outboard left wing. It had then rocked over onto the outboard region of the right wing before coming to rest with the tail resting lightly in the upper branches of a tree. It was concluded that the impact with the ground was consistent with the aircraft being in a spin to the left, with the velocity vector primarily in the downwards, as opposed to horizontal, direction.

The forward fuselage was severely compressed during the impact, such that that the left side of the instrument panel had been pushed rearwards into the cabin. The left wing root had been severely disrupted at the junction with the fuselage, with the rear spar attachment having broken. The left wing had remained attached although there had been some movement relative to the fuselage.

The propeller blades displayed evidence of chord-wise scoring, and a propeller 'chop' mark was found on the ground at the impact point, indicating that the engine was developing power.

It was observed that the flaps were at their maximum deflection of 40°. The inboard end of the right flap was in contact with the right hand side of the rear windscreen and the fuselage skin immediately below, causing distortion. There were no scrape marks or abrasion damage to either; it was therefore concluded that the flaps were in this position prior to impact (Figure 3).



**Figure 3**

As-found flap position, showing damage to rear windscreen and sill structure below

It was found that there was plenty of fuel aboard the aircraft. When the Fire and Rescue Service attended, fuel was reportedly leaking from the right wing tank fuel filler cap; they had stopped the leak using a clay compound. However, it was subsequently found that much of the fuel in both tanks had seeped away via a broken fuel line in the engine compartment.

Although the Alternator/Battery Master switch was found in the OFF position, the turn and slip gyroscope motor could be heard running for approximately eight hours after the accident.

The trim tab was noted to be in line with the elevator and thus in an approximately neutral position.

Following an on-site examination the aircraft was recovered to the AAIB's facility for more detailed inspection.

## **Aircraft information**

### *General*

The C150 is a side-by-side, two-seat training and general use light aircraft. It was in production between the years 1959 to 1977; thereafter it was replaced by the C152. Although it has many similarities with the C152 model, and the two are often considered as a single type, there are some significant differences. Flap selection and indication are different and the C152 has a greater available payload. A study by the General Aviation Safety Council suggests that the accident rate in the UK is higher for the C150 than for the C152<sup>1</sup>.

### *Flaps*

The wing flaps on G-BDZC were electrically operated, with a motor-driven actuator in the right inboard wing driving a screw jack. A nut on the jack in turn drove a pulley; cables transferred the pulley rotation to an identical component in the left wing. Control rods were attached to the pulleys and flaps such that pulley rotation resulted in the flaps extending or retracting. Limit switches on the actuator cut the electric power at the fully extended and retracted positions.

A mechanical flap position indication was provided in the left forward door post/windscreen pillar; in addition the flap extension could be seen from within the cockpit. The indicator consisted of a spring-loaded pointer running in a slot in the pillar, with calibration marks from 0° to 40° on the surrounding trim. A cable connected to the pointer ran via a conduit in the left wing root and was attached at its other end to the flap system pulley cable such that flap movement caused the indicator cable, and hence the pointer, to move in proportion.

Wing flap selection on G-BDZC was controlled by a switch on the lower centre instrument panel (Figure 4a). To extend the wing flaps the switch must be held against spring pressure in the DOWN position; when released the switch will return to the centre NEUTRAL/OFF position. To retract the flaps the switch had to be selected and held to the UP position; the switch would return, under spring pressure, to the neutral position when released. It would take

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### **Footnote**

<sup>1</sup> GASCo study: 'A Study of Fatal Stall or Spin Accidents to UK Registered Light Aeroplanes 1980 to 2008'

approximately 9 seconds to fully extend the flaps in flight and 6 seconds to retract them. The flap switch did not give a visual indication of the selected flap position.

The final production models of the C150 were fitted with a re-designed flap selector with detents for the flap positions and a position indicator located beside the switch. The C152 flap selection and indication is similar (Figure 4b), but the maximum flap travel was reduced from 40° to 30°.



**Figure 4a**

C150 flap selector switch as fitted to G-BDZC



**Figure 4b**

C152 flap selector/indicator switch

## Aircraft examination

The examination of the aircraft focused primarily on the flap operating system. It was decided to apply power to the flap system electrical circuit in order to operate the actuator. This involved restoring the electrical wiring between the fuselage and the right wing, as it had been necessary to cut them during the removal of the wings before the aircraft was recovered to the AAIB. As a result of structural distortion that occurred in the impact, it was necessary to remove the flap actuator from the right wing.

Prior to applying power, the flap switch was checked for correct operation, with the spring biasing towards the central position being found to be satisfactory. The continuity or open circuit conditions for the switch positions were checked against the appropriate circuit diagram and were found to be correct. Finally, an electrical power supply was connected to the flap switch and it was found that the actuator responded to the flap switch selection and could be moved to its up/down limits, where it was stopped by the limit switches. It could also be halted at any intermediate position.

Elsewhere in the flap system it was noted that the flap position indicator cable had broken close to its attachment to the cable linking the two pulleys. The latter cable had broken during the impact as a result of relative movement between the wings and fuselage. The possibility was considered that the failure of the indicator cable may have occurred prior to impact, which would have caused the pointer to indicate zero flaps regardless of their actual position. The cable failure was subjected to a metallurgical examination, which confirmed that the failure was due to overload and thus had occurred at impact. It is likely this occurred as a result of the failure of the pulley cable; each section either side of the failure would have recoiled due to the release of strain energy, causing a snatch load on the much lighter indicator cable.

Elsewhere on the aircraft it was found that a degree of charring had occurred on a sheath containing a cable bundle behind the left side of the instrument panel. This appeared to be the result of partial penetration by a piece of sheet metal from the fuselage ahead of the left side of the windscreen. Opening up the sheath revealed that the lead connecting the battery to the master switch had been cut and the insulation had burned away over a localised area, exposing the conductor. This damage also extended to an adjacent cable, where the conductor had also been exposed. The damage had effectively bypassed the master switch, with the short circuit accounting for the fact that the electrics could not be turned off by the first responders.

## Aircraft performance

The aircraft was subject to additional limitations for performance calculation in accordance with 'CAA Change Sheet 1, Issue 1, to the Cessna 150M 1976 Flight Manual.' This change requires the addition of 15% to the scheduled takeoff run and distance, and a decrease to the scheduled rate of climb of 150 ft/min. At the maximum weight of 726 kg and in the prevailing conditions the aircraft should have required 520 m takeoff distance to clear a 50 ft obstacle. The distance from the start of Runway 18 to the line of trees is 740 m.

Takeoff performance figures are not provided for other than the flaps-up position, but a note in the Flight Manual indicates that although the ground roll may be reduced with flap 10°, takeoff distance to 50 ft will not be improved. The Flight Manual includes the following note:

*'Flap deflections greater than 10° are not recommended at any time for take-off.'*

The instructor who had flown with the pilot stated that he thought it was likely that 10° flap would have been selected for takeoff on the grass runway surface. This was the club policy and had been practised during the training and familiarisation flights.

## Pilot's checklist

The checklist provided in the Flight Manual does not include an action to deploy the flaps prior to a walkround inspection. However, the pilot's commercially available checklist, like many others commonly in use, does include this action.

The instructor commented that the pilot's use of the checklist was methodical and during training they had some discussions about the layout of his checklist. Specifically, it was discussed that the selection of the master switch on as part of the 'Internal' checks, before carrying out a long sequence of actions including retracting the flap, might drain the aircraft battery. The instructor noted that the pilot had made some marks on his checklist to highlight the problem. The instructor stated that he had suggested that the pilot should comply with the checklist, but perhaps purchase the one used at the club which had a different pre-start sequence.

The pilot's checklist, recovered from the aircraft after the accident, showed that two items of the 'Internal' checks had been amended by hand, changing the order of actions prior to engine start (Figure 5).



**Internal**

- |                     |  |
|---------------------|--|
| 1. Seat             | - Adjusted and locked  |
| 2. Harness          | - Secure   |
| 3. Brakes           | - On   |
| 4. Fuel             | - On   |
| 5. Master Switch    | - On and check fuel gauges rise                                  |
| 6. Circuit Breakers | - In (except Radio Fan/Strobe CB if fitted)                      |
| 7. Cabin Air/Heat   | - Controls set closed  |
| 8. Flaps            | - Up and check symmetrical operation                             |
| 9. Mixture          | - Exercise and set fully rich                                    |
| 10. Throttle        | - Loosen nut, exercise and set 1cm open                          |
| 11. Carb. Heat      | - Exercise and set to cold air                                   |
| 12. Trim            | - Exercise through range, check correct sense and set to neutral |
| 13. Controls        | - Full and free movement in the correct sense                    |
| 14. Electrics       | - All Off  |
| 15. Instruments     | - Glasses unbroken, figures legible and within limits            |
| 16. Radios          | - All Off  |
| 17. Datcon reading  | - Record for tech. log   |

**Starting and After Start**

- |                  |  |
|------------------|--|
| 1. Brakes        | - On (reminder check)  |
| 2. Beacon        | - On   |
| 3. Key           | - In   |
| 4. Prime         | - Carb Heat HOT, Prime as required (check locked)              |
| 5. Lookout       | - All clear, visual & verbal                                   |
| 6. Start         | - Rotate key to start position (Brakes holding)                |
| 7. RPM           | - Set to 1200 rpm, Carb Heat COLD                              |
| 8. Starter Light | - Out (if On, STOP ENGINE)                                     |
| 9. Oil Pressure  | - Rising into green arc within 30 seconds (if not STOP ENGINE) |
| 10. Ammeter      | - Check Positive reading                                       |
| 11. Suction      | - Available  |

**Figure 5**

Pilot's amended checklist

The pilot's checklist was found open at the 'Vital Actions' and 'Take Off' page. The 'Vital Actions' section of the checklist includes an action to select Flap 10° for takeoff. This was in accordance with the club policy.

**Weight and balance**

According to the most recent Weight and Balance schedule for G-BDZC, dated 10 July 1996, the Basic Empty Weight was 517 kg (1,142 lb) and the Maximum Authorised Weight (MAW) was 726 kg (1,600 lb). The aircraft was fitted with a 49 litre fuel tank in each wing, giving a maximum fuel capacity of 98 litres, of which 13 litres were unusable. Using the best available data, a post-accident weight and balance calculation was completed; 22 kg (48 lb) of baggage recovered from the aircraft was included. The result suggested that the aircraft was within the allowable CG range, but approximately 40 kg (88 lb) above the MAW.

## Accident history

### GASCo study

The GASCo study of UK stall/spin accidents noted:

*'There have been 11 accidents on the Cessna 150 but only one on the Cessna 152, with 60% more hours flown by the C152.'*

The reasons for this apparent difference in accident rate between the variants was not fully explained, although some of the handling characteristics were further explored. A recommendation made in the report was:

*'The Cessna 150 and Cessna 152 should not be treated as the same type and in particular pilots transferring from the Cessna 152 to the Cessna 150 should undertake formal Familiarisation Training.'*

### Inadvertent deployment of 40° flap

The AAIB has reported on two previous fatal accidents where the unintended deployment of Flap 40° in a Cessna 150 was considered to be a factor. In February 1999, during a practice EFATO manoeuvre demonstrated by an instructor, a C150 aircraft (G-AZLL) stalled and entered an incipient spin with 40° flap set. In September 2015, a student pilot lost control of the aircraft when the flaps were extended to 40° during an attempted go-around.<sup>2</sup>

On 21 June 2013, at Oakland County International Airport USA, a Cessna 172, (registration N9926Q) with four persons on board crashed on takeoff, fatally injuring all those on board. The aircraft had a similar spring-loaded flap selection system to G-BDZC. The accident was investigated by the NTSB and the final report contained the information:

*'Air traffic control tower personnel saw the airplane lift off the runway and attain an altitude of about 100 feet. A pilot approaching the runway for landing saw the airplane lift off and noticed it was not climbing.'*

and

*'A post-accident examination revealed that the wing flaps were fully extended (40 degrees).'*

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## Footnote

<sup>2</sup> [https://assets.publishing.service.gov.uk/media/54230004e5274a13140009f3/dft\\_avsafety\\_pdf\\_501786.pdf](https://assets.publishing.service.gov.uk/media/54230004e5274a13140009f3/dft_avsafety_pdf_501786.pdf)  
[https://assets.publishing.service.gov.uk/media/5768089ded915d3cfd0000a6/Cessna\\_150F\\_G-ATKF\\_07-16.pdf](https://assets.publishing.service.gov.uk/media/5768089ded915d3cfd0000a6/Cessna_150F_G-ATKF_07-16.pdf)

## Survivability

Both seats were equipped with lap and diagonal safety harnesses; these were found to be intact after the accident. It was observed that the left side of the instrument panel had been pushed rearwards, which had had the effect of reducing the space between the seat back and the panel. It was considered that the more severe damage to the left side was a consequence of the initial impact being on the left wing.

## Meteorology

The Cambridgeshire area was influenced by an unstable air mass. The general weather conditions were clear, with scattered cumulus cloud and a south-westerly airflow. Two people working on top of shipping containers at the airfield, who were experienced at observing wind speed, noted that the wind was gusty; they estimated the wind speed as being up to 18 kt. The METAR from Cambridge Airport, 8 nm to the east, reported a surface wind from 220° at 10 kt, visibility more than 10 km, few cloud at 1,200 ft, temperature 15° C, dewpoint 10° C and pressure 1017 hPa.

## Pilot information

The pilot started flying powered aircraft in 1998, having previously flown gliders. He qualified on both Touring Motor Gliders (TMG) and Single Engine Piston (SEP) aircraft; most of his recorded flying was on TMGs. In April 2016 he started flying Cessna aircraft at several clubs in the Cambridgeshire area. He joined the flying group at Bourn in July 2016 and was checked out by an instructor. After completing his checkout he flew a couple of times with the instructor acting as a safety pilot, before deciding to fly on his own with a passenger. He completed a 20-minute solo flight in the C152 aircraft on 1 September 2016 but, prior to the accident, he had not previously flown the C150 without the instructor.

The instructor advised that the pilot had flown from Runway 18 previously. He also noted that during the pilot's training all pre-takeoff checks had been completed with the aircraft at the run-up area, before entering the runway to backtrack for takeoff.

## Analysis

### *General*

The aircraft took off but failed to climb sufficiently to clear a line of trees beyond the end of the runway. The takeoff was attempted with 40° flap, probably unintentionally, which led to an inability to climb because of the additional drag. This was exacerbated by the aircraft being above its maximum allowable weight. A gentle turn to the left towards open ground or an early decision to abort the takeoff and land ahead could have prevented the accident. It is likely that the pilot did not realise why the aircraft was not climbing. A late attempt to retract the flap would not have been an effective mitigation, as it takes approximately 6 seconds to fully retract the flaps and flap retraction would have caused a temporary loss of climb performance.

### *Flap system examination*

Examination of the flap operating system revealed no evidence of pre-impact failure, with the flap actuator correctly responding to selections made by the switch on the instrument panel. As a result, it was concluded that the possibility of the flaps making an uncommanded selection to full extension was remote.

The flap indicator system was also examined, as it was considered that a pre-impact failure of the cable attached to the pointer would have given a zero indication even if the flaps themselves were fully extended. However, a metallurgical examination of the cable concluded that the failure occurred as a result of overload applied during the accident sequence.

### *Preparation for the flight*

The flaps were seen to be fully deployed during the pilot's pre-flight inspection and it was not determined whether they were ever retracted subsequently. The flap switch on this aircraft did not give any visual cue of the flap position, unlike the otherwise similar C152 aircraft. Thus, the flap may have remained deployed until takeoff, or it may have been re-deployed prior to takeoff. In the latter case the pilot would not have intended to deploy full flap, so its selection would have been accidental. To deploy the flap to 40° requires a sustained action on the switch for about 9 seconds, so it is unlikely that this would be achieved by an accidental input, although it remains a possibility.

If the pilot had completed the actions as detailed on his amended checklist, that is, the master switch remaining OFF until immediately before engine start, then with no electrical power the flaps would not have retracted at '*Item 8 Flaps - Up and check symmetrical operation.*' In this circumstance it is possible that the position of the flaps and their failure to move when selected UP escaped his notice.

The next opportunity to check the flaps through use of the checklist was as part of the '*Vital Actions*', where the flaps are set at 10° for takeoff. However, there are eleven items in this section of the checklist and a further five items for the '*Take Off*' checklist. It would be easy to overlook one action, and there is the potential for additional distraction with a passenger on board. It is also of note that the majority of the pilot's previous flying had been in touring motor glider aircraft which were not equipped with flaps.

### **Previous Cessna 150 Flap 40-related accidents**

Significant differences exist in the design and operation of flaps between the C150 and the C152 aircraft. The C150 has the facility to deploy 40° flap, but inappropriate use of this flap causes performance penalties and handling problems which can lead to accidents for unwary pilots. The spring-loaded switch, as fitted to G-BDZC and most C150 aircraft, does not give the pilot a visual cue of the selected flap position, unlike C152 aircraft. It is therefore important that this difference is emphasised during pilot training.

There have been two recent accidents in the UK whereby the inadvertent use of 40° flap on the Cessna 150 aircraft has been a causal factor. It is considered that a greater focus during training/type familiarisation on flap selection and indication, and the effect of full flap configuration on aircraft performance and handling characteristics, could prevent further accidents. The following Safety Recommendation is therefore made:

**Safety Recommendation 2017-013**

It is recommended that the Civil Aviation Authority promulgates to flying instructors the need for specific training to highlight the differences between the C150 and C152 flap switch designs. Training should also include the effect on aircraft performance and handling of Flap 40°.

**Conclusion**

The takeoff was attempted with 40° flap and in this configuration the aircraft was not able to climb due to the excess drag. It is probable that the flaps were unintentionally left deployed following their extension for the pre-flight inspection.