AIRCRAFT ACCIDENT REPORT 5/80

Department of Trade

ACCIDENTS INVESTIGATION BRANCH

Cessna F 172 L G-BFKS

Report on the accident 1 mile south-west of Wycombe Air Park, on 12 December 1979

LONDON

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5/80	Cessna F 172 L G–BFKS Wycombe Air Park December 1979	

ISBN 0 11 512983 9

Department of Trade
Accidents Investigation Branch
Kingsgate House
66–74 Victoria Street
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21 November 1980

The Rt Honourable John Nott MP
Secretary of State for Trade

Sir,

I have the honour to submit the report by Mr P J Bardon, an Inspector of Accidents, on the circumstances of the accident to Cessna F 172 L G-BFKS which occurred one mile south-west of Wycombe Air Park, on 12 December 1979.

I have the honour to be
Sir
Your obedient Servant

W H Tench
Chief Inspector of Accidents

Accidents Investigation Branch

Aircraft Accident Report No: 5/80
File Ref: EW/C685

Operator:		Wycombe Air Centre Ltd
Aircraft:	*Type:*	Cessna F 172 L
	Nationality:	United Kingdom
	Registration:	G-BFKS
Place of Accident:		One mile south-west of Wycombe Air Park Lat 51° 36′ 25″ N Long 000° 45′ 30″ W
Date and Time:		12 December 1979 at 1324 hrs All times in the report are GMT

Synopsis

The accident was notified to the Accidents Investigation Branch by Wycombe ATC at 1344 hrs on 12 December 1979 and an investigation was commenced that day.

The aircraft was making a private flight in the local area and took off from runway 25 at Wycombe Air Park at 1323 hrs. In addition to the pilot, there were three male passengers on board. The pilot intentionally selected almost full flap for take-off and the aircraft required a ground run of more than usual length in which to become airborne. After take-off, the aircraft ceased to climb after gaining something less than 100 feet. The pilot was unable to prevent the speed decaying, despite partial retraction of the flaps, and the aircraft stalled. It entered a wood at a steep angle and came to rest inverted. There was no fire. Two of the passengers were killed and the other occupants seriously injured.

The report concludes that the accident was caused by the pilot's use of excessive flap for take-off at a time when there was a partial loss of engine power due probably to carburettor icing. The slightly over-loaded condition of the aircraft and deficiencies in the pilot's knowledge of aircraft operation were contributory factors.

1. Factual Information

1.1 History of the Flight

The pilot arrived at Wycombe Air Centre (WAC) with three male companions at about 1245 hrs with the declared intention of flying to Boston, Lincolnshire. He asked the receptionist where he could obtain information about Boston since he could find nothing about it in the Air Pilot. The receptionist advised him the Air Touring Guide contained the information that Boston airfield was unlicensed and that its runway was at least 100 metres shorter than Wycombe. She also reminded him that it would be dark by 1545 hrs and queried whether he could return by then, since he was not rated to fly at night. The pilot then declared that he would go to Peterborough instead, and obtained the authorisation of the Chief Flying Instructor (CFI), who also reminded him that there was only a limited amount of daylight remaining. The pilot then went out to the aircraft but because the CFI was not satisfied that the pilot had briefed himself properly, he too went to the aircraft and asked the pilot if he had looked at the weather. He replied that he had not, so he returned to the club house with the CFI who discussed the weather with him. The CFI then asked the pilot about his fuel requirements to which the pilot replied that he would need more than was on board. After instructing the pilot to taxi the aircraft to the fuel pumps, the CFI went out to check the amount of fuel on board. A short while later he spoke to the refueller and instructed him to refuel the aircraft to not more than three quarters full. The CFI has since realised that this was an error as he intended that the aircraft should only be filled to half tanks. He further reminded the pilot about the limited amount of daylight remaining and instructed him to return by no later than 1530 hrs. Subsequent to this, the pilot and his passengers boarded the aircraft, which was then observed to taxi fairly fast to the holding point of runway 25. There were approximately 6 or 7 other aircraft manoeuvring on the ground in the same area at the time. The CFI, who was by then in another aircraft and about to fly with a student, heard Air Traffic Control (ATC) calling G-BFKS repeatedly before the aircraft responded. ATC then asked if it was the pilot's intention to land away from base, to which the pilot replied that he intended to fly to Peterborough. When ATC pointed out to him that he had not booked out, the pilot then said he would remain in the local area. The CFI had, by this stage, been on the point of cancelling G-BFKS' flight to Peterborough because he was concerned about the lateness of the hour and the forecast of deteriorating weather. However having heard the pilot of G-BFKS announce his intention of staying in the local area, the CFI turned his attention to his own tasks.

G-BFKS then called for take-off clearance, but once again did not acknowledge ATC's reply. After a short delay, during which time two other aircraft were given take-off clearance, G-BFKS again called and this time responded immediately to ATC. During the time the aircraft was at the holding point, it was observed to be standing on wet grass. The aircraft's take-off was observed by the CFI's student who noted that its acceleration was slower than normal and that an unusually large amount of flap had been extended. G-BFKS became airborne at what appeared to be near the end of the runway and at a slower speed than normal. The aircraft was also seen to develop a yawing oscillation whilst attempting to climb. The CFI's student then lost sight of the aircraft, but he mentioned his observations to the CFI, who was pre-occupied with what he was doing and seemed not to hear. One other witness reported essentially the same observations as regards G-BFKS' take-off, including the fact that a large amount of flap appeared to have been extended. The pilot has since confirmed that he selected

'almost full flap knowing that the last few degrees were pure drag'. He did not comment on the aircraft's performance during the ground roll, but stated that after becoming airborne he realised he was 'short of power'. He was not aware of a complete loss of power, only that the airspeed would not increase and that he could not maintain height. He states that he retracted the flaps as much as he dared, but he was sure that he did not retract them fully. The indicated airspeed at this stage was about 45 mph, according to the pilot's recollection.

The aircraft was seen to be flying in a pronounced nose-up attitude at a height of about 150 feet, alternately sinking and rising, but not making an overall gain in height. After a short while, the port wing and the nose were seen to drop, and the aircraft side-slipped to the left into some trees, the tops of which extended some 50 to 60 feet above the plane of the runway.

The aircraft came to rest inverted on the far edge of a wood bordering the airfield. It sustained severe damage but there was no fire. Two of the passengers were killed on impact and the pilot was seriously injured. The other passenger sustained moderate injuries, but was able to extricate himself from the wreckage.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	–	2	–
Serious	1	1	–
Minor/None	–	–	–

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

A number of trees were damaged and the surface of farmland was disturbed by vehicles attending the crash site.

1.5 Pilot Information

1.5.1 *Commander:* Male aged 36 years

Licence: Private Pilot's Licence (PPL). Group A
Certificate of Test dated 2 March 1979

Medical certificate: Valid until 31 May 1980

Flying experience: 51 hours 10 minutes all of which were on the Cessna 150 except 50 minutes on the Cessna 172.

1.5.2 *Pilot Experience*

The pilot began flying training on 10 January 1978 at WAC and after 17 hours 40 minutes dual instruction, made his first solo flight on 26 May of that year. He qualified for a Private Pilot's Licence (PPL) on 31 January 1979, having flown a total of 37 hours dual and 10 hours 15 minutes solo, all of which were on the Cessna 150 aircraft. The pilot's training record showed normal progress with no significant weaknesses in flying technique.

After obtaining his PPL, the pilot flew on six occasions during 1979 prior to the accident flight, for a total of 3 hours 55 minutes. He did not fly at all from 5 June to 28 September, when he underwent a 10 minute check flight in accordance with WAC rules. Thereafter he flew twice, once on 4 October and again on 28 November when he was checked out on a Cessna 172 in the course of a 50 minute flight. For this check, the aircraft was loaded to a high all up weight in order to give the pilot experience of flying in this condition. His instructor states that the weight limitations for the 172 were explained to him and also that the pilot used the correct flap setting for take-off. Furthermore the pilot's handling of the aircraft, including stalling, was considered satisfactory. The pilot's next flight was the accident flight itself, two weeks later.

During his training, the pilot landed away from Wycombe on a number of occasions. Once was on 23 October 1978, when in the course of a cross country flight he landed at Cranfield and Coventry. The other occasion was a dual flight which terminated at Cranfield. In addition, he also made a night landing away from base with his instructor.

1.5.3 *Pilot's knowledge of the aircraft*

The pilot had not studied the Cessna 172 manual at all and he was therefore unaware of the weight and balance limits for the aircraft or how they were calculated. He was also unaware that in the Owners Manual for the Cessna 172, it is recommended that flap settings greater than 10 degrees are not used for take-off at any time.

The Owners Manuals were not available at WAC for retention by pilots since they formed part of each aircraft's documentation library, though they were accessible at any time for those who wished to see them. Nevertheless, since May 1979, WAC has produced its own aircraft manuals, including those for the Cessna 150 and 172 and these contain essentially the same information to be found in the Owners Manuals. The WAC Cessna 172 manual was on display and for sale in the flight office at the time the pilot made his check flight on the Cessna 172. However, the pilot did not purchase one and has since said that he was unaware of its existence.

1.5.4 *Pilot Ground Training*

The pilot chose not to take an Approved Course of training for his PPL and thus he was not required to receive a specific amount of classroom tuition. Instead, his ground training was largely based on home study supported by ad hoc lectures from his flying instructor as and when the opportunity occurred. No record of the ground training given to the pilot was kept, nor was it required to be kept.

1.6 Aircraft Information

1.6.1 General Information

Manufacturer:	Reims Aviation, France
Date of manufacture:	1972
Registered owners:	Wycombe Air Centre Limited
Certificate of Airworthiness:	Valid until 22 March 1980 Maintained in accordance with schedule (GPMS)
Total airframe hours:	2,533
Engine type:	Avco-Lycoming 0-320-E2D
Total engine hours:	430
Weight at time of take-off (calculated):	2,401 lbs (using nominal fuel load and basic weight recorded in the aircraft's documentation)
Actual weight at the time of take-off:	2354 lbs (ie based on weight of wreckage and accurate measurement of fuel load)
Maximum weight authorised:	2300 lbs
Centre of gravity limitations:	At Normal Category weight of 2299 lbs Forward limit + 38.58 inches Aft limit + 47.24 inches
Estimated centre of gravity at time of take-off:	+ 45.15 inches
Fuel type:	100LL

1.6.2 Take-off Check Lists

With respect to the flap setting to be used for take-off, the check list in the aircraft's Owner's Manual states that the wing flaps should be set to zero degrees for a normal take-off and also for a maximum performance take-off. Further on in the Manual, under the section entitled Take-Off, it is stated that normal and obstacle clearance take-offs are performed with the wing flaps up. However, the use of 10 degrees of flap is envisaged for take-offs when the minimum ground run is required or from soft or rough surfaces. If 10 degrees of flap is used for take-off, it is recommended that no attempt be made to retract them until the obstacle is cleared and the aircraft is accelerating to its normal flaps up climbing speed of 80 to 90 mph. The section concludes with the statement that flap settings greater than 10 degrees are not recommended at any time for take-off.

The check list cards being used by the pilot were produced by Airtour Flight Equipment Ltd. The Pre-Take Off Check List states simply that the wing flaps can be set 'as required'.

The WAC Cessna 172 Manual in the section entitled 'Take-Off – Wing Flap Settings', repeats the information contained in the Owners Manual with the exception of the concluding statement that flap settings greater than 10 degrees should not be used. Instead, it states that flap settings of 30 to 40 degrees are not recommended at any time for take-off.

1.7 Meteorological Information

An observation taken at Wycombe airfield at 1325 hrs recorded the following:

Surface wind:	130 to 190 degrees at 6 kts
Visibility:	more than 10 kms
Cloud:	6/8 at approximately 6,000 feet.

A Meteorological Office aftercast was prepared and gave essentially the same information.

No surface temperature or dew point was recorded at Wycombe but the Meteorological Office advised that the relative humidity was in the region of 80-84%. The surface temperature at Wycombe has been estimated to have been approximately 7° C. These conditions were conducive to carburettor icing at any power.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

Not applicable.

1.10 Aerodrome Information

The airfield is at an elevation of 520 feet above mean sea level (AMSL) and the dimensions of the single tarmac covered runway 25/07 are 2401 x 75 ft.

1.11 Flight Recorders

None required and none fitted.

1.12 Examination of Wreckage

1.12.1 On-site Examination

The aircraft had entered the wood left wing low, banked approximately 20° to 25°, with a nose-down attitude of approximately 30°. The speed was estimated to be 65 mph. The main impact was taken by the left wing leading edge and left forward fuselage area. The aircraft entered the trees on an approximate heading of 260° magnetic and finally came to rest on a heading of 255° magnetic. At the time of impact, the aircraft was structurally complete.

Detailed examination of the wreckage on-site produced strong evidence that the engine was developing high power at impact and the propeller blades had high rotational speed. The flaps were found to be in the retracted position, the elevator trim halfway between take-off and full nose-up and the engine cockpit controls consistent with a high power setting. Inspection of the engine showed no evidence of malfunction and there were no abnormalities in the flying controls. There was no evidence of an over rich mixture on the spark plugs, such as might be associated with carburettor icing, nor were there any signs of water having been present in the carburettor choke tube or on the butterfly.

1.12.2 Subsequent Detailed Examination

The aircraft wreckage was examined in detail, with particular emphasis on the engine, the flight instruments and the flap system. The engine was removed from the airframe and externally examined and no damage or defect was found. The spark plugs were examined and two of the lower plugs were found to have heavy lead deposits between the centre electrode and the plug casing. The spark plugs were static tested and no fault was found. The engine was installed on a test bed and taken through a CAA approved test schedule. The engine power was found to be 98.5 per cent of the full power rating which was within the minimum allowable (98 per cent). A second test run was carried out after the two spark plugs with heavy lead deposits had been replaced and the engine power was then 100 per cent.

The Air Speed Indicator and Vertical Speed Indicator were subjected to a calibration check. The Air Speed Indicator was found to be serviceable but the Vertical Speed Indicator was found to be just outside the calibration limits.

The flap system was closely examined and evidence was found which indicated that the flaps were extended upon impact. The exact amount of extension could not be determined except that it was in excess of 11° but not more than 22°.

No fuel was found in the aircraft but there was evidence that fuel had been present in the fuel tanks at impact. A fuel sample was taken from the airfield refuelling point, and upon analysis was found to comply with specifications.

The examination of the aircraft as a whole revealed no evidence of any abnormality and it is considered that the aircraft was free of any defect at the time of the accident.

1.13 Medical and Pathological Information

A post mortem examination of the two deceased passengers found no evidence of a medical condition that could have contributed to the accident.

1.14 Fire

There was no fire.

1.15 Survival Aspects

The aircraft was seen to descend into the trees by the Wycombe Air Centre receptionist who telephoned ATC. The Duty Aerodrome Flight Information Officer alerted the public emergency

services by telephone and at the same time requested a helicopter which was operating nearby to attempt to locate the aircraft. This it quickly did and remained in the area to guide the emergency services to the crash site which they reached at about 1345 hrs. The scene was attended by a police vehicle, three ambulances and two fire vehicles. Access was difficult due to the soft ground and the vehicles became bogged down. On arrival at the aircraft, the rescuers found three persons trapped in the wreckage, two of whom appeared to be dead and the third injured. A fourth person (later established to be one of the passengers) was found some distance from the wreckage, conscious but in pain. The injured were immediately taken to hospital and the two deceased passengers removed from the wreckage shortly afterwards. All occupants of the aircraft had been wearing seat belts, the attachments of which had remained intact. In addition the pilot and front seat passengers had been wearing diagonal upper torso restraint. The occupant of the rear left seat, which was not fitted with upper torso restraint, died due to head injuries. The occupant of the right front seat died from multiple injuries involving a haemorrhage into the chest and a severe blow across the front of the neck.

1.16 Tests and Research

A flight test was conducted at Cranfield on a Cessna 172 loaded to the maximum authorised weight of 2300 lbs in order to establish the aircraft's behaviour on take-off with 30 degrees of flap set. It was considered that this setting was the one most likely to have been used by the pilot on the accident flight.

It was found the aircraft became airborne at about 60 mph IAS after a ground run of 17 seconds duration. The surface wind provided a 15 kt headwind component. The climb was established at 65 mph IAS at a rate of 250 ft/min. A take-off was made with the flap retracted, which is the normal setting. The aircraft became airborne at 70 mph IAS in 15 seconds and at a climb speed of 80 mph IAS, the rate of climb was 320 ft/min. A series of stalls was carried out at full power with the flaps set at 30 and 40 degrees. The stall occurred at approximately 35 mph IAS and was accompanied by a gentle wing drop to the left. With full flap, essentially the same result was obtained. With the aircraft held just on the stall at between 35- 45 mph IAS, the flaps were raised progressively from the fully extended position. The speed was observed to increase by 15 mph with no loss of height.

2. Analysis

2.1 Circumstances of the Accident

The cause of the accident was clearly related to the pilot's use of almost full flap for take-off, of which there is indisputable evidence, though it cannot be shown that this was the sole cause. The results of the brief flight test demonstrated that, though the aircraft's performance was degraded to some extent, the aircraft would still climb after take-off with 30 degrees of flap set. Furthermore, the partial retraction of flap resulted in a prompt increase in airspeed, which in the event could have been traded for an increase in rate of climb. However, the results of the flight test have to be seen in the correct context which is that the aircraft was being flown by a highly experienced pilot off a relatively long runway. The test did not therefore reflect accurately the circumstances facing the pilot of G-BFKS. Nevertheless, there would still seem to have been some other factor present in the accident sequence which not only prevented the aircraft from climbing but which caused a further loss of airspeed despite the pilot's partial retraction of flap. The pilot maintains that this additional factor was a partial loss of engine power shortly after becoming airborne and that this was the sole reason for his inability to keep the aircraft airborne. There is no direct evidence to support this contention, other than eyewitness reports that the aircraft's take-off run was unusually long and that it failed to climb after becoming airborne. Clearly the engine must have been developing a substantial amount of power in order to become airborne at all with a high flap setting and at a high all up weight.

In addition the damage caused by the propeller during its passage through the trees was indicative of high engine power at that time. Also, when the engine (which was quite undamaged in the accident) was test run, it was found to meet its power output requirements, even with two leaded spark plugs. It follows therefore that any power loss must have been due to a transient effect, most probably carburettor icing, of which there was a high risk in the prevailing meteorological conditions. In support of this, there is evidence that the aircraft stood for a comparatively lengthy period of time on wet grass at the holding point with the engine slow running. This would have considerably enhanced the risk of carburettor icing. That being so, the pilot should have been alert to this possibility and given a prolonged application of carburettor heat immediately prior to commencing his take-off run. There is no evidence that he did so, apart from his pre-take-off functional check of the system which would have been too brief to prevent the subsequent formation of ice.

In conclusion therefore, it is considered that the aircraft's lack of climb performance after take-off was the result of the combined effect of excessive flap, high aircraft weight and probably carburettor icing. All of these factors were avoidable and their effects could have been anticipated. Of the three, the overweight condition was the least significant and would have had a negligible effect on the aircraft's performance had that been the only consideration.

2.2 Flap Setting for Take-Off

The pilot's rationale for using 'almost full flap' (which has been interpreted as being at least 30 degrees) appears to have been based upon his understanding that the more flap he used the more lift he would obtain which he considered he needed because of the number of people on board. However he did realise that 'the last few degrees were pure drag'. In fact, anything in excess of 10 degrees was bound to degrade the aircraft's take-off performance. This can be

clearly inferred from the Owners Manual where it recommends that no more than this amount should be used at any time for take-off. The pilot's ignorance of this recommendation stemmed not only from his failure to read that particular paragraph, but also because he had clearly not absorbed the instruction he had received with respect to this aspect during his PPL training and during his check out in the Cessna 172. Nevertheless, had the pilot wished to explore the question of the proper flap setting for take-off, he would have found the situation far from clear. Even though the Owners Manual (the definitive document as far as the operation of the aircraft is concerned) is quite specific on the subject, it still nevertheless only **recommends** that flap settings greater than 10 degrees should not be used. The Airtour check list cards, which the pilot was using, simply states that the flaps should be set 'as required'. To compound the situation still further, the WAC Cessna 172 Manual though stating that zero flap should normally be used, does go on to say that '30 to 40 degrees of flap are not recommended for take off', thereby implying that up to 20 degrees may be used, which in fact is the setting that should be used for touch and go landings only. However, the WAC Manual does refer to the aircraft's Flight Manual or Owners Manual as being the authoritative source.

2.3 Pilot Training

The evidence is that in respect of the three factors that contributed to the accident, namely the flap setting, carburettor icing and the aircraft's weight, the pilot had received the requisite training. However, his actions on the day of the accident, from the time that he arrived at the airfield, would seem to indicate that he had by no means absorbed that training, though this does not seem to have been apparent when he was checked out on the 172. It is accepted that during that check flight, the pilot used the correct flap setting and had the weight limitations explained to him. He also satisfied the instructor concerned as to his handling of the aircraft, including stalling. Nevertheless, it is a fact that two weeks after that check the pilot was involved in an accident in which two people lost their lives because he misused the flaps, failed to check the aircraft's weight and did not take adequate steps to recognise and prevent the probable onset of carburettor icing. In addition to this, the pilot did not check the weather, book out properly with ATC or study the aircraft manual before flight.

2.4 Supervisory Aspects

It might be argued that the WAC management should have recognised that the pilot was exceeding his personal limitations and thus prevented him from flying. This argument cannot be sustained since the CFI, on this occasion, did all that he reasonably could to monitor the pilot's activities, short of cancelling the flight, which as matters stood he could not justifiably do. It was unfortunate that the CFI unwittingly contributed to the overloading of the aircraft by ordering an excess amount of fuel to be put aboard the aircraft, but this was indicative of the pressure that he was undoubtedly under at the time. In any case, the ultimate responsibility for the correct loading of the aircraft rests with the pilot in charge of it, if he is a licence holder, and not the CFI. It is therefore considered that the WAC acted responsibly in this matter and that there was little else that could have been done to prevent the pilot from flying or carrying passengers.

3. Conclusions

(a) *Findings*

(i) The aircraft had been maintained in accordance with an approved maintenance schedule and its documentation was in order, though the basic weight stated on the aircraft's Weight Schedule was possibly some 57 lbs in excess of the actual weight.

(ii) The weight of the aircraft at the time of take-off was some 54 lbs in excess of the authorised maximum but this was not considered to be a major contributory factor to the accident.

(iii) The pilot had made no pre-flight weight and balance computation in accordance with the advice contained in the Owners Manual and it was his responsibility to do so. Had he made this computation, using the available documentation, the weight would have been calculated to be 2401 lbs, that is 101 lbs over the authorised maximum.

(iv) The Chief Flying Instructor inadvertently ordered an excess amount of fuel to be put aboard the aircraft which thus contributed partly to its overweight condition. At the time, he was under considerable pressure of work.

(v) The pilot was properly licenced but there were deficiencies in his knowledge of his aircraft's operation which contributed to the accident.

(vi) The pilot had not studied the Owners Manual for the aircraft and his resultant lack of knowledge as to the recommended flap settings and his consequent use of the wrong setting was a major contributory factor to the accident.

(vii) On circumstancial evidence, there appears to have been a partial loss of engine power for which no technical or mechanical cause was found. It is concluded, therefore, that the loss of power was most probably due to the carburettor icing, of which there was a high risk at the time. It follows therefore, that the pilot did not take adequate precautions prior to take-off to prevent the formation of ice in the carburettor.

(viii) The aircraft's lack of climb performance after take-off was due in part to the high flap setting used by the pilot, a high aircraft weight and a partial loss of engine power.

(b) *Cause*

The accident was caused by the pilot's use of excessive flap for take-off together with a partial loss in engine power due probably to carburettor icing. The slightly over-loaded condition of the aircraft and deficiencies in the pilot's knowledge of aircraft operations were contributory factors.

P J BARDON
Inspector of Accidents

Accidents Investigation Branch
Department of Trade
November 1980

Produced in England by Her Majesty's Stationery Office, Reprographic Centre, Basildon

Bas 80430/R151 725 12/80 P