ACCIDENT

Aircraft Type and Registration:	Cessna 150F, G-ATKF	
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine	
Year of Manufacture:	1965 (Serial no: 150-62386)	
Date & Time (UTC):	4 September 2015 at 1110 hrs	
Location:	Hinton-in-the-Hedges Airfield, Northamptonshire	
Type of Flight:	Training	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Fatal)	Passengers - N/A
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	None (student)	
Commander's Age:	39 years	
Commander's Flying Experience:	33 hours (of which 33 were on type) Last 90 days - 33 hours Last 28 days - 10 hours	
Information Source:	AAIB Field Investigation	

Synopsis

Following a bounced landing, the student pilot applied power to go around. The aircraft lifted off, adopting a level attitude with a small climb rate. The pilot extended the flaps but did not control the natural tendency for the aircraft to pitch up as a consequence. The aircraft adopted a steep nose-up attitude, stalled and entered a spin to the left from which there was insufficient height to recover. The aircraft struck the ground in a steep nose-down attitude.

History of the flight

The pilot of G-ATKF was a solo student undergoing training for a Private Pilot's Licence (PPL) and, during the morning of the accident, had flown six glide approaches with an instructor. The purpose of the flight was solo consolidation of glide approaches. The wind was from 320° at 7 kt, there was broken cloud at 4,000 ft amsl, visibility of more than 10 km and the temperature was 16°C.

People sitting on a raised platform controlling parachute activity at the aerodrome observed the accident. They often watched G-ATKF making approaches and they reported that on this occasion it had flown two or three circuits using Runway 24 before the approach which led to the accident. One of the witnesses was of the opinion that the aircraft had a small amount of flap extended as it passed his location (Figure 1). He reported that it touched down on its nose landing gear in line with, or just beyond, two cones which were placed one either side of the runway. The aircraft sat back onto its main landing gear, bounced back into the air and, after floating along the runway, touched down again, left main landing gear first, close to the intersection of the taxiways with the runway marked in Figure 1.

The aircraft appeared to settle onto the runway after which power was applied and it lifted off and adopted a level attitude. The witnesses reported that the aircraft appeared to be flying slowly, heading to the left of the runway centreline and climbing gently, when it began to pitch up steadily into a steep nose-up attitude. One of the witnesses, observing through binoculars, stated that he saw flaps extending as the aircraft was pitching up. The aircraft was observed to bank to the left after which the nose attitude decreased rapidly and the aircraft descended and struck the ground.

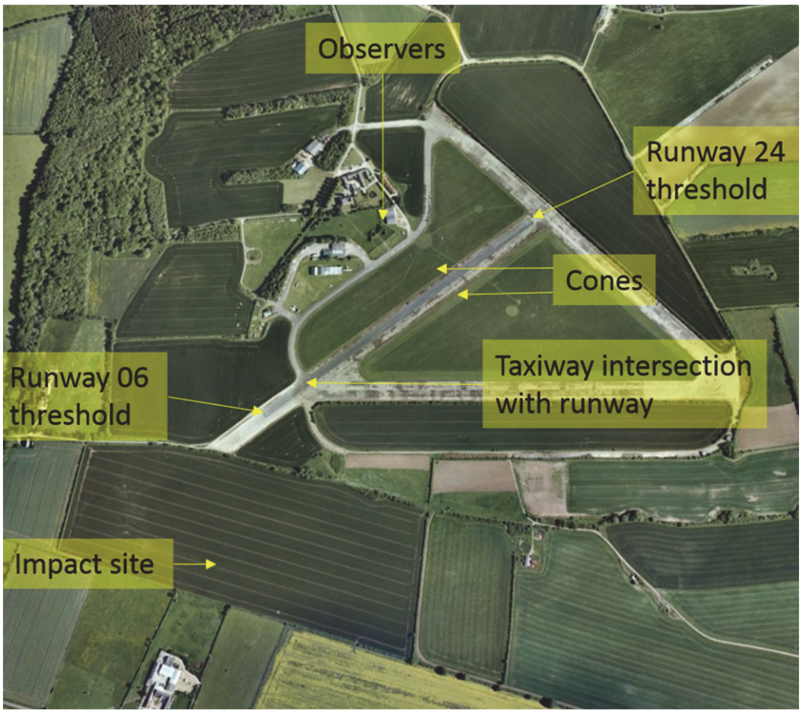

Figure 1

Overhead image of the accident site (Google Earth)

Aircraft description

G-ATKF was an all-metal high wing monoplane powered by a flat four-cylinder Continental Motors piston engine driving a two-blade fixed pitch propeller. It was a two-seater fitted for dual control and was used for general aviation and PPL training.

Flying controls and flaps

The Cessna 150F has conventional flying controls with control yoke and rudder inputs transmitted mechanically to the control surfaces via rods, cables and bell-cranks. The aircraft is fitted with inboard trailing edge flaps which are electrically driven by a motor and screw jack mounted within the wing structure on the right side of the aircraft. The left and right flaps are linked and synchronised by a system of cables and pulleys between the two flaps. The flaps are controlled by a three-position spring-loaded switch in the cockpit. The switch is held up or down against spring pressure to motor the flaps to the desired setting and when released returns to centre whilst the flaps remain in their set position.

Stall warner

The aircraft is fitted with a simple stall warning system which gives an audio indication to the pilot of the onset of wing stall. The stall warner consists of a small orifice in the leading edge of the left wing attached via a tube to a pneumatic device sensitive to vacuum which emits an audible 'whistling' warning tone.

G-ATKF history and records

The aircraft's Certificate of Airworthiness was issued on 29 November 2012 and it had a valid Airworthiness Review Certificate, due to expire on 20 February 2016. At the time of the accident the aircraft had accumulated a total of 12,632 airframe hours and the most recent 50-hour check was carried out at 12,593 hrs, on 18 August 2015. The aircraft had a comprehensive set of technical records which had been kept up to date and there were no deferred defects recorded. The technical log showed that the aircraft had flown regularly in the days leading up to the accident. The aircraft was flown by the pilot and his instructor for 55 minutes immediately prior to the accident flight.

Accident site

The aircraft came down 230 m from the end of the concrete surface in a stubble field with a dry densely packed stony soil surface (Figure 2). It had impacted the ground nose-down at an estimated angle between 10 and 15° from the vertical, leaving a 150 mm deep impression in the soil. The nose landing gear had detached and the aircraft had fallen back to rest upright on its main landing gear which was displaced, twisted and folded underneath the aircraft. One of the propeller blades was curved to the extent that the tip was pointing forwards. The other blade was less damaged, with slight distortion to its tip and deep nicks in the leading edge. The propeller spinner was crushed against the propeller boss leaving impressions of the propeller attachment bolts.

Within the cockpit, the instrument panel and coaming were caved in and a number of the instruments were displaced and severely damaged. Despite this it could be determined that the altimeter was set at 1016 hPa. The fuse panel had bent inwards and the cubby cover panel above the row of fuses had detached from the facia. Two of the fuse holders had been damaged but all the fuses were in place and intact.

The wing had twisted and was no longer perpendicular to the centreline of the fuselage, and both wingtip leading edges were crumpled and distorted. The flaps were down and were rigidly in position. Despite the overall damage there was aileron control system continuity, with slight movement of the ailerons in the correct sense. The rudder and elevator had a full range of movement but were disconnected from the rudder pedals and control yoke due to damage in the cockpit area sustained in the impact.

The engine was generally intact although its bearer frame was severely distorted. There was oil in the sump and showing on the dipstick; however there was a small amount of oil leakage into the engine bay. There was fuel on board the aircraft in both tanks and there was no leakage. The right magneto was still attached and the left was loose due to the mounting flange having broken.

The master switch was off and the ignition key had been removed along with battery disconnection by the first responders to the accident.

The pilot had been sitting in the left seat, wearing the standard three point harness. During the rescue operation the first responders had undone the buckle. However, the short strap and clasp assembly had already detached from the aircraft floor. Damage to the buckle strap mounting bracket bolt showed that it had been pulled out of the anchor nut in the floor. The strap fabric, buckles and clasp were otherwise in good condition.

Figure 2
Accident site and impact mark

Detailed examination

The aircraft was recovered to the AAIB hanger at Farnborough and a more detailed examination carried out.

The stall warner orifice protective gauze was intact and clear of debris. A test was carried out on the stall warning system and it was found to produce normal tone when subjected to a vacuum.

The initial examination at the accident site established a continuity of the flying controls as far as the instrument panel, but they did not appear to be connected to the rudder pedals and control yokes. The yoke shafts had broken at the drive quadrants and were hanging loose, as were the rudder bar linkage assemblies. The elevator trim wheel and its housing had disintegrated and were found loose on the cockpit floor. It was therefore not possible to establish the trim settings prior to the accident.

The flap linkages and drive system were at the same setting each side and by measurement of the screw jack extension were found to be at 38° down. This was corroborated by angular measurement on the wing. The screw jack assembly, motor, wiring and the wing structure surrounding the flaps and drive system were undamaged, although the mainplane displacement had put the flap synchronisation cables under tension, causing them to disengage from their pulleys.

The flap switch and wiring were examined and tested for continuity and found to be serviceable. A 40 amp standard fuse was fitted in the flap circuit although the fuse holder cap had fallen onto the cockpit floor. All the aircraft electrical system fuses are identified by etched and embossed labels on the facia. The flap fuse is normally marked SLO-BLO[1] but, in this case, an alteration had been carried out whereby a 60 amp breaker had been fitted in the SLO-BLO location and labelled ALT, referring to the aircraft alternator. The flap fuse holder had been relocated next to this breaker and relabelled FLAP.

Pathology

The post-mortem examination, which consisted of an external examination and CT scan, did not identify any evidence of natural disease sufficient to have caused or contributed to death. However, medical incapacitation could not be excluded. The examination identified that the deceleration force experienced by the pilot was predominately in the back-to-chest direction and that he died as a result of a head injury.

The toxicology report showed no evidence that the pilot was under the influence of drugs or alcohol at the time of the accident, or that he had been exposed to significant amounts of carbon monoxide.

Pilot information

The student pilot began his flying on 6 June 2015 and first flew solo on 17 August 2015 after 22 hours of instruction. He flew nine flights subsequently which included instruction on flying glide approaches (see next section). Before the accident flight, the student had flown 27 hours with an instructor and three hours solo.

The pilot had been taught low speed handling, with and without flaps extended, earlier in the PPL syllabus as a prelude to being taught about stalling. His training to handle the aircraft with flaps set to 40° had been limited to a demonstration in which he was told that, when applying power, the aircraft attitude was to be held steady and flaps raised to 20° in order to prevent the speed from decreasing. He had been taught not to use 40° of flap to steepen the approach flightpath angle if the aircraft appeared to be high, and his experience of going around had been with 20° or 30° of flap, not 40°.

Footnote

[1] 'Slo-Blo' Fuse – The 'Slo-Blo' nomenclature was used by the manufacturer. It is a fuse which is designed to allow a delay prior to breaking the circuit when its current rating is exceeded.

Training for glide approaches

PPL syllabus

The EASA PPL syllabus is divided into a series of 19 exercise groups. Exercise 13 covers the skills required to fly circuits[2] including: departing and joining the circuit; normal powered approaches to a landing, touch-and-go, or go-around; flapless approaches; and glide approaches (where the approach is made with the throttle at IDLE to simulate an engine malfunction and loss of power). Students fly their first solo flight on Exercise 14 after which they consolidate their learning with a series of dual and solo flights within the circuit area.

In flying glide circuits, students learn how to use flap to control the aircraft's flightpath and touchdown point. At the beginning of a glide approach an 'initial aiming point' (IAP) is chosen approximately one third of the way along the runway to give a target touchdown point. If an aircraft is above the ideal approach angle (and is therefore likely to land beyond the IAP), flap can be extended to steepen the approach and bring the expected touchdown point back towards the IAP. If an aircraft is below the ideal approach angle, it might be able to touch down between the threshold and IAP but, if it is expected to touch down before the threshold is reached, power will be used to complete a normal landing or go-around. A glide approach will have a higher rate of descent than a normal approach and slightly more anticipation is required during the flare before touchdown.

General training at Hinton-in-the-Hedges

Runway 24 at the aerodrome is 700 m long and the operator carried out a risk assessment treating the limited runway length as a hazard. The risks identified were: unstable approach resulting in landing too far into the runway; mishandling resulting in a late go-around at low speed; and mishandling following a go-around. Following the assessment, a rule was introduced to instruct solo students to go around if the aircraft's main wheels were not firmly on the ground by the end of the touchdown zone (TDZ), marked by the cones either side of the runway. Touch-and-go landings are not flown because of the limited runway length and, when practising circuits, the aircraft is brought to a halt after landing and then taxied back along the runway to the takeoff position for the next takeoff.

Glide approach training at Hinton-in-the-Hedges

The student was taught to begin a glide approach on the base leg of the circuit by closing the throttle, flying the aircraft at 65 kt and turning onto the runway centreline. The IAP at the aerodrome is marked by the cones shown in Figure 1 and the student was taught to go around if the aircraft had not touched down by the time it reached the cones. If the aircraft had touched down by the cones, it could be brought to a halt prior to the next takeoff.

Footnote

2 A circuit is the pattern described by an aircraft taking off and positioning immediately for landing. Aircraft approaching an aerodrome can often join the circuit on different 'legs' of the pattern.

Go around

The student was taught the go-around procedure for approaches flown with 20° or 30° of flap and on one occasion was demonstrated a go-around from an approach with 40° flap. He was taught to apply full power to go around and anticipate the need for right rudder input to counter the slipstream effects of the propeller. He was taught to raise the flaps to 10°, select a level aircraft attitude and hold it to avoid the speed decreasing, and then raise the flaps to 0° once the aircraft reached 65 kt.

Cessna 150F Owner's Manual

The Cessna 150F Owner's Manual states:

> *'Normal and obstacle clearance take-offs are performed with the flaps up. The use of 10° flaps will shorten the ground run … but this advantage is lost in the climb to a 50-foot obstacle. If 10° of flaps are used … it is preferable to leave them extended … in the climb to the obstacle. Flap deflection of 30° and 40° are not recommended at any time for takeoff.'*

Engineering analysis

Although the aircraft was complete and in one piece, the impact had caused substantial damage and disruption to the nose, wing and rear fuselage of the aircraft. The distortion of the nose section and the ground marks were consistent with the aircraft impacting the ground at a steep angle. The nature of the crushing and distortion of the propeller spinner and the damage to the underside of the nose cowling suggested an impact angle approximately 15° from the vertical.

Marks made by the wingtips and associated damage showed that the aircraft hit the ground on its nose, then, as the nose structure deformed, the wing twisted in relation to the fuselage. The wingtip ground marks also implied a slight anti-clockwise rotation of the aircraft as it hit the ground. The attitude of the aircraft at impact and the nature of the wingtip ground marks indicated the aircraft had entered a spin. Witness evidence also suggests that this was the case and the aircraft dropped nose-down near vertical from an estimated height of between 150 and 200 ft. From this height it is estimated that the deceleration forces exerted on the pilot were in excess of 85g during the impact.

The buckle strap floor-mounted bracket and attachment between the seats had detached in the impact. This was as a result of distortion of the cockpit floor folding around the anchor nut such that it became misshapen and released its grip on the mounting bolt, whilst it was under a high tensile load at the moment of impact.

The rudder, aileron and elevator flying control components behind the instrument panel had been severely disrupted; this was wholly attributable to the impact. However, the flying control system and surfaces were found to be correctly assembled and working in the correct sense throughout the rest of the fuselage and wings. There was no evidence to suggest a malfunction of the flying control system prior to the accident.

The examination of the flap system also found no evidence of pre-accident fault or failure and it can be concluded that its electromechanical drive system was operating correctly and responding to the pilot's inputs.

The non-standard modification carried out replacing the alternator fuse with circuit breaker and transposing it with the 'Slo-Blo' fuse holder, fitted with a standard 40 amp fuse, had no effect on the flap system operation and therefore had no bearing on the accident.

The damage to the propeller indicates that one of the blades cut into and drew itself deeply into the soil at the point of impact (Figure 3). The extent of the bend of this blade indicates that it was under high power at this point and the relatively little damage to the other blade shows that the propeller was brought to a stop in one revolution or less. The very steep aircraft angle at impact meant the propeller was presented to the soil almost fully face-on and did not exhibit the multiple progressively increasing tip impacts characteristic of a more shallow impact angle. The propeller effectively tried to 'screw' itself into the ground, causing extreme bending and leading to the conclusion that the engine was at a high power setting.

Figure 3

Propeller damage

The aircraft was well-used and showed signs of wear and tear commensurate with its age, but there was no evidence to suggest the aircraft was unserviceable at the time of the accident. In summary, the aircraft was considered to be airworthy, with systems responding correctly to pilot input prior to the accident. All the disruption and damage to the aircraft was consistent with an impact with the ground at a steep angle.

Operational analysis

Witness evidence suggested that the aircraft lifted off from the runway at a point beyond the taxiway intersection, began to climb gently and turned left. The left turn was consistent with there being insufficient right rudder input to offset the turning effect of the propeller's slipstream at low speed and high power. The turn might also have been due to a small angle of bank to the left, although the witnesses reported that the aircraft began to bank only after it began to pitch up.

The aircraft appeared to be climbing slightly until the flaps began to extend to 38° (the maximum setting is 40°). Extending flap increases lift initially (with a small increase in drag) but, for large flap angles, the drag increases without a proportionate increase in lift. In a high-wing design, such as the Cessna 150, increasing drag by extending flap to its maximum setting tends to cause the aircraft to pitch nose-up and it is likely that, in this accident, this tendency was not controlled by the pilot. With a high nose attitude, there would not have been enough thrust to maintain the airspeed which would have reduced until the wing stalled (observed in this case as the aircraft banking to the left and the nose attitude decreasing rapidly). The aircraft appeared to have entered a spin, adopting a low nose attitude and rotating to the left, until it struck the ground. This was consistent with the physical evidence of the aircraft wreckage.

The limited runway length had been identified as a hazard by the operator and, consequently, students had been instructed to go around if they did not touch down by the time they passed the cones positioned on either side of the runway. It was not determined why the student did not go around after bouncing at a point near the cones. Instead, he applied power once the aircraft settled onto the runway near the taxiway intersection and the aircraft lifted off shortly thereafter.

The flap setting as the aircraft lifted off was not determined, although witnesses reported that the flaps had been extended as the aircraft passed the cones. The aircraft Owner's Manual states that the advantage of using 10° flap (to shorten the takeoff ground roll) is lost during the initial climb, and that takeoffs with flaps set to 30° or 40° are not recommended. The aircraft appeared to have been climbing slightly before it pitched up, which would have been unlikely had the flaps been set to 30° or 40°. On balance, it was likely that the flap was set to approximately 10° as the aircraft lifted off.

The student had been taught that, during a go-around, he should raise the flaps to 10°, select a level aircraft attitude, accelerate to 65 kt and then raise the flaps to 0°. Therefore, the student would have been expected to raise the flaps at about the time they were extended. Given that the flap system was found serviceable, it was concluded that the flaps were operated by the student. The student must have been holding the flap switch while the aircraft was pitching up because, had he released the switch, the flaps would have stopped extending (and they were found almost fully extended). It could not be determined whether he intended to extend the flaps, or whether he intended to raise them but lowered them in error. However, the fact that the pilot was operating the flap switch during the manoeuvre that led to the stall, suggested that he was not medically incapacitated.

Conclusion

Following the bounced landing, the student pilot applied power and the aircraft lifted off and began climbing gently. For reasons that could not be determined, the pilot extended the flaps but did not control the aircraft's natural tendency to pitch up as a consequence.

The airspeed reduced and the aircraft stalled and began to rotate to the left, probably because it was entering a spin. There was insufficient height to recover and the aircraft struck the ground in a steep nose-down attitude.