Cessna 182T Skylane, N666JH

AAIB Bulletin No: 3/2004	Ref: EW/C2003/08/01	Category: 1.3
Aircraft Type and Registration:	Cessna 182T Skylane, N666JH	
No & Type of Engines:	1 Lycoming IO-540-AB1A5 piston engine	
Year of Manufacture:	2001	
Date & Time (UTC):	1 August 2003 at 1530 hrs	
Location:	Horton Wood near Marlow, Buckinghamshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Fatal)	Passengers - N/A
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	Private Pilot's Licence with IMC Rating	
Commander's Age:	78 years	
Commander's Flying Experience:	4,810 hours (of which about 1,300 were on type)	
	Last 90 days - 42 hours	
	Last 28 days - 10 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The aircraft departed Wycombe Air Park en route to Rochester and three minutes later entered a spiral dive from which it did not recover. No pre-existing aircraft defects were found in the wreckage and the available evidence suggests that the pilot became partially incapacitated.

History of flight

The pilot, who was also the owner of the aircraft, had delivered the aircraft to Wycombe Air Park on 22 July 2003 for its annual service. On the day of the accident, he arrived at Wycombe Air Park (having travelled there principally by train) with the intention of flying the aircraft back to his home base of Rochester. The aircraft had just over half-full fuel tanks and was not refuelled. The pilot 'booked out' intending to fly under Visual Flight Rules (VFR) and did not file a flight plan. As he taxied out towards Runway 24, another aircraft was landing and the local weather was discussed over the radio. The landing pilot described the cloud base as "between two and three hundred feet". This message was acknowledged by the pilot of N666JH who stated that the weather at his destination was much better. He then departed from Runway 24 and climbed ahead to about 200 feet agl before commencing a right-hand turn and disappearing into cloud. The aircraft was heard flying overhead the airfield and departing to the east which was consistent with the planned route to Rochester. Two minutes after takeoff the pilot transmitted 'GOING OVER TO THAMES NOW, TWENTY TWO HUNDRED FEET'. No further transmissions were received from the aircraft. It was last seen in a descending, right-hand turn with the engine running and moving 'extremely fast', about 800 metres from its point of impact. There was also an ear witness who heard the sound of an aircraft followed by a loud thump and then silence.

Radar Data

A radar head located at Heathrow Airport recorded most of the aircraft's flight. This showed the aircraft departing Wycombe Air Park and flying a climbing right-hand turn through 250° back to the airfield overhead. It then tracked approximately 100° for 75 seconds, climbing to and then maintaining 2,500 feet amsl. During this period the aircraft speed steadily increased to 140 kt groundspeed. This period of straight and level flight then ended with a tightening right hand turn and a rapidly increasing rate of descent. At the last position recorded by the radar, which was approximately 100 metres from the point of impact, the aircraft had a rate of descent of over 16,000 ft/min and had turned through 180° since departing straight and level flight.

Search and rescue

Nobody in the vicinity of the airfield or the crash site appreciated that the aircraft was in difficulty so there were no reports to the emergency services at around the time of the accident. Later that evening the aircraft was reported overdue by a relative of the pilot. The Distress and Diversion cell at the London Terminal Control Centre (LTCC) receive many similar calls each week and, without corroborative evidence of a mishap, the staff decided to await airfield opening hours the following morning before initiating tracing action. Commensurate with checking airfields along the route, a radar replay from the Heathrow radar head was studied and it revealed the aircraft's flightpath. A Search and Rescue helicopter was then deployed to search the area surrounding the point where the aircraft disappeared below radar coverage. The wreckage was located close to that point at 1015 hrs on the morning after the accident.

Pathology

Although it was not physically possible to determine the presence of any pre-existing disease, it was established that there was no evidence of any toxicological factors that may have contributed to the cause of this accident. The aviation pathologist's opinion however, was that the pilot's age and complex medical history suggested that incapacitation may have been a causal factor.

Meteorology

An aftercast obtained from the Meteorological Office at Bracknell showed a light, moist, westerly flow with a weak cold front moving slowly across the area. The cloud was overcast with the base lowering to 800 feet amsl in drizzle. The accident site was approximately 400 feet amsl. The cloud base element of the aftercast concurred with the pilot report of a cloudbase between 200 and 300 feet over Wycombe Air Park, which is 500 feet amsl. The surface wind was from 200° at 8 kt and the wind at 2,000 feet amsl was from 230° at 12 kt. At Rochester, which was ahead of the cold front, the weather reports described good visibility and little cloud below 5,000 feet.

Accident Site

The aircraft had crashed into woodland about ½ mile from Hard to Find Farm near Marlow, Bucks. From overhead the accident site, damage to the treetops showed that the right wing had cut a swath through the trees indicating the aircraft was in a tight right turn, consistent with a spiral dive. As it entered the woodland, further tree damage showed that the aircraft was at an attitude of 65° of right bank with 30° nose-down pitch. The right wing continued to cut through trees before the aircraft struck the ground, tearing the right wing from the fuselage. The forward section of the aircraft left an impact crater approximately 2.6 metres in diameter and 0.5 metres deep, consistent with a very high rate of descent at an estimated speed of about 200 kt. The aircraft had then pitched over on its nose and to the left before rolling over and in the process, suffering severe fragmentation due to the high impact speed and multiple collisions with trees in the wreckage path. Several items had detached from the inside and the outside of the airframe during the impact sequence, the furthest of which was approximately 30 metres away from the main wreckage. The bulk of the aircraft finally came to rest around a large oak tree, about 10 metres from the initial impact crater.

Within the wreckage trail were two of the three propeller blades and they both showed extensive damage to their leading edges. The relatively undamaged third blade, thrown during the break up of the propeller hub, landed about 18 metres to the right of the wreckage. Inspection of the fuel injection

servo revealed a witness mark left by the butterfly valve on the body of the unit, indicating that it was at the full throttle position at impact.

Despite the extensive fragmentation of the aircraft, all of the main structural elements and flying control surfaces were located at the accident site. The failures of these items were consistent with the high impact forces experienced during the crash, and did not show any signs of in-flight failure or detachment.

Aircraft Description

General

N666JH was a high wing monoplane with a single piston-engine driving a three-bladed variable-pitch propeller. The aircraft had cable operated conventional flying controls and used electrically signalled but mechanically driven flaps via an electrical motor and screwjack to cables and pulleys. The elevator trim used a cable connected to a screwjack attached to the elevator trim tab.

The aircraft was relatively new having been constructed in 2001. It had completed 212 hours in service and the maintenance during that time consisted of two annual services; the most recent of which immediately preceded this accident.

Autopilot (AP)

The autopilot (AP) fitted to N666JH was a two-axis Honeywell KAP-140. This could control the aircraft in pitch and roll using electrically signalled control servos. These autopilot servos connected directly onto the cables that operated the ailerons, elevators and elevator trim. Accelerometers, a pressure transducer and the turn co-ordinator provided input signals for the AP control modes.

On initial power up of the aircraft avionics, using the avionics master switch, an initial built-in test of the AP begins and provides an indication on the AP computer screen with the letters 'PFT' and an increasing number. If the test is passed the screen segments are all displayed with a short AP disconnect warning sounding; the screen then blanks and the AP passes into a standby but not controlling state.

Engagement of the AP is via the AP button on the front of the computer. When pressed the AP engages into the initial, basic, control modes of wings level and vertical speed capture, thus maintaining the aircraft's existing vertical speed at the time the AP button is pressed. By additionally pressing the appropriate mode button on front of the computer, the heading hold (HDG) and altitude hold (ALT) will engage. When in heading select mode, the AP will command the aircraft to turn onto the selected heading using a maximum rate commensurate with a rate one turn (3°/sec).

A separate configuration module holding information pertinent to the aircraft type is utilised by the AP computer. In addition, the module has the ability to record faults that occur during the power up tests and holds these in a non-volatile memory.

Autopilot modification

Prior to an AP modification KAP140-M1, as specified in Cessna Service Bulletin (SB) 02-22-01, selecting either the AP, HDG or ALT buttons would immediately engage the AP. Following the modification, the AP button must be pressed and held for 0.25 seconds before the autopilot will engage. This modification is intended to reduce the probability of inadvertent engagement should the button be unintentionally pressed.

The pilot/owner of N666JH was aware of this modification to the AP that had resulted from an accident to a similar Cessna 182, G-BYEG in May 2001 (see AAIB Report EW/C2001/5/4 Bulletin 3/2002). He had requested, on many occasions and prior to the annual maintenance, this particular modification to the AP to reduce his risk of the potential problem. The modification to the KAP-140 AP in N666JH was carried out in accordance with Cessna Service Bulletin (SB) 02-22-01 and

Honeywell SB KAP140-M1. These service bulletins required the software in the AP computer to be re-programmed.

After removal of the AP computer at Wycombe and shipping to Kidlington, an avionics overhaul facility carried out the software upgrade. A later flight of N666JH to Kidlington then enabled fitting and testing of the now modified AP computer. The aircraft then returned to Wycombe. Thorough testing of the AP on the bench at Kidlington after the modification and subsequently in the aircraft (but on the ground) showed it to operate satisfactorily. Following the modification the associated paperwork and changes to the manuals, required by the SBs, were carried out and passed to the pilot/owner when he collected the aircraft prior to the accident flight.

After the accident, other aircraft that had the same modified software installed in their AP computers, at Kidlington, prior to and after embodiment in N666JH, have been flight tested with no reported problems.

Detailed Wreckage Examination

The aircraft wreckage was recovered to the AAIB facility at Farnborough for a detailed examination. Inspection of the multiple failures to the cables operating the flying controls revealed that they were consistent with overload failure because of the impact; there were no pre-existing defects and they were correctly connected. The elevator trim screwjack was intact and fixed in its last selected position of about 5° nose down pitch. The flap screwjack actuator showed a position consistent with flaps UP.

Strip examination of the turn and slip indicator revealed witness marks on the rotor of the gyro indicating that the unit was operating at the time of impact. Inspection of the vacuum operated attitude direction indicator (ADI) showed that due to impact damage to the instrument case, the ADI had frozen the indication at impact. The indicated attitude was very similar to the estimated aircraft impact attitude that was determined at the accident site of 65° right bank and 30° nose-down pitch. A further strip examination showed witness marks on the rotor of the gyro, which also showed that it was operating at the time of impact. The remaining instruments had been too extensively damaged to provide meaningful data.

Impact loads experienced by the AP computer caused extensive damage which precluded any further examination of the unit. The AP configuration module was not recovered, despite an extensive search of the accident site and the wreckage, but if this module had been missing, then the AP would not have operated or passed its initial power up tests at Kidlington. Therefore, the module must have been fitted to the aircraft but the force of the impact may have destroyed it.

N666JH was equipped with an Emergency Locator Transmitter (ELT). Following recovery from the wreckage, its selector switch was found in the AUTO position. The unit had detached from its airframe fixture resulting in a damaged case and the aerial lead had detached from its connector; this rendered the ELT inoperable.

Maintenance

The accident flight was the first flight following full completion of the maintenance carried out at Wycombe Air Park. A review of the annual inspection paperwork did not reveal any problems with the flying controls, structure or powerplant of the aircraft. The only rectification work carried out was minor in nature and was normal for a relatively new aircraft such as this. After the airframe and engine maintenance elements had been completed, the aircraft was flown to and from Kidlington for the AP software change. The AP computer was not fitted on the flight to Kidlington and the AP was not used for the return flight. However, no problems were encountered with the engine or airframe on either of these 'delivery' flights.

Flight Tests

A flight test was conducted in a similar Cessna 182 aircraft fitted with a KAP-140 autopilot in an attempt to determine whether the autopilot had been used during the initial turn after takeoff. The

autopilot took 83 seconds to fly the initial turn through 250° which, at 3.01°/sec, is consistent with the AP target rate of 3°/sec. Measurement of the accident aircraft's radar track showed that the same turn took 56 seconds to complete which, at 4.46°/sec, is significantly faster than a rate one turn.

An attempt was also made to recreate the final flightpath of the aircraft in a generic light aircraft simulator. Whilst accepting that the fidelity of the simulator prohibits detailed use of the results, it was noted that a significant control column pull was required at a late stage of the dive to match the data provided by radar analysis.

Analysis

The two 'delivery' flights between Wycombe and Kidlington demonstrated that there was nothing fundamentally wrong with the aircraft's structural integrity, the flying controls and the engine controls. Also, the aircraft's powerplant was delivering high power at impact which suggests that engine power loss was not a causal factor in this accident. Moreover, notwithstanding the extensive disruption to the aircraft, the engineering investigation was unable to find evidence of any other pre-existing aircraft defects, autopilot failure or autopilot malfunction. Therefore, whilst firm conclusions cannot be drawn, it appears likely that the primary causal factors for the accident were operational rather than technical.

The report from the pathologist indicated a number of factors that could have led to pilot incapacitation. Although there was no audible sign of distress when the pilot made his last radio transmission, there followed a 40 second period of flight before the start of the spiral dive when he would have been expected to check in on the new radio frequency. He had earlier read back the frequency to Wycombe Air Park ATC and as such would probably have preselected it on the radio, making normal frequency changeover almost instantaneous. The new frequency was quiet at the time and there does not appear to be a particular reason for not checking in.

Attempts to recreate the final flightpath in a generic light aircraft simulator could only be achieved by significant control column pull at a late stage of the spiral dive. Although this appears inconsistent with total incapacitation, it could be consistent with a partial incapacitation, whereby the pilot retained some limited control enabling him to reduce the dive and bank angle but not by enough to effect recovery. The fact that the throttle was left fully open suggests that the pilot was perhaps not fully aware of his predicament, since closing it would be the usual initial action in recovering from a steep dive.

Although he had recently renewed his IMC rating, it was the pilot's normal practice to use the autopilot for the majority of a flight. Flight tests using a similar aircraft and autopilot show that he almost certainly did not have the autopilot engaged during the prolonged initial turn onto his outbound course and he was probably in cloud during the brief cruise phase. It is possible that he became distracted during the radio frequency change. In particular, since he was used to the autopilot flying the aircraft, he may not have noticed the divergence from straight and level flight whilst hand flying the aircraft during the radio frequency change. If a roll divergence had been allowed to develop into a spiral dive, correct recovery action would have required closing of the throttle, levelling of the wings and pulling out of the dive. This sequence of events does not appear to have been followed.

Medical and flightpath analysis suggests that partial incapacitation was likely to have occurred. The degree of incapacitation probably affected the pilot's abilities without rendering him unconscious. Its effects may have led to his entering a spiral dive and may have been responsible for his inability to recover from it successfully.