Accident

Aircraft Type and Registration:	Extra EA-200, G-EEEK	
No & Type of Engines:	1 Lycoming AEIO-360-A1E piston engine	
Year of Manufacture:	2006 (Serial no: 1034)	
Date & Time (UTC):	13 July 2024 at 1142 hrs	
Location:	Spanhoe Airfield, Northamptonshire	
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	
Commander's Age:	65 years	
Commander's Flying Experience:	At least 4,076 hours (of which approximately 1,100 were on type) Last 90 days – at least 225 hours Last 28 days – at least 81 hours	
Information Source:	AAIB Field Investigation	

Synopsis

After flying to Spanhoe Airfield, Northamptonshire, the pilot of G-EEEK pitched the aircraft into a vertical climb and completed a manoeuvre from which the aircraft entered an upright flat spin to the left. The aircraft was not recovered before it struck the ground, and the pilot was fatally injured.

The investigation was unable to establish why the pilot flew such manoeuvres, unapproved and at low level. It was not possible to exclude a control restriction or a pilot incapacitation for the lack of sufficient recovery before the aircraft struck the ground.

History of the flight

The pilot had flown the aircraft from Fowlmere Airfield, Cambridgeshire to Spanhoe Airfield, Northamptonshire to meet a friend. On arrival at the airfield, the pilot flew a fly past before pitching up to the vertical during which he performed a number of aileron rolls. At the apex of the climb, the aircraft was manoeuvred, entering a flat spin to the left from which it was not recovered before it struck the ground by the entrance track to the airfield. The pilot was fatally injured.

Accident site

The aircraft struck the ground in a wooded area approximately 170 m to the south of Runway 09-27, adjacent to the airfield access road. The compact nature of the accident site, lack of ground impact marks away from the aircraft wreckage and relative lack of distortion to the fuselage's welded steel frame showed that the aircraft had struck the ground at low speed in an approximately level pitch and roll attitude (Figure 1). Three-phase electrical cables directly above the aircraft wreckage were intact, apart from minor fire damage, indicating that the flight path prior to impact was not vertical to the ground and that the aircraft had a low degree of forward speed at impact. The low forward speed was further confirmed by the lack of significant forward displacement of debris from the main aircraft wreckage.

Figure 1
G-EEEK accident site

An intense post-impact fire had occurred, consuming the majority of the flammable material of the aircraft's structure, and it was not possible to determine if the aircraft had been rotating in yaw at impact.

Examination of the aircraft wreckage at the accident site confirmed that all major airframe structural elements, control surfaces, canopy, landing gear, engine and propeller were present. Damage to the aircraft's three-bladed wooden propeller showed that the propeller had been rotating under power at impact. The pilot was sitting in the rear seat, with the steel buckle of the seat harness present in the rear cockpit, however the seat belt straps had been consumed by fire. The accident was not survivable.

Witnesses

There were few witnesses who saw the final part of the flight although a number of others at the airfield heard the aircraft as it passed over. Witnesses reported seeing the aircraft pass low over the airfield before pulling into a vertical climb. During the climb the aircraft rotated about the vertical axis a number of times. At the top of the climb the aircraft was seen to 'fall' into a descent with a rotation to the left. A witness familiar with the aircraft described seeing it in a flat spin to the left. All the witnesses reported that the aircraft noise was loud and that they could hear the engine running at high power.

CCTV supported the witness recollection and allowed the final manoeuvres to be assessed although the aircraft was a significant distance away from the CCTV camera. The aircraft is seen to pitch up into the vertical, completing at least four aileron rolls to the right whilst in the climb. At the top of the climb the aircraft is seen to complete some kind of ballistic manoeuvre which results in a flat spin to the left. The aircraft is seen on the CCTV to complete at least four turns in the spin before it is lost to sight behind trees.

Recorded information

Two different CCTV cameras captured G-EEEK during the arrival and manoeuvres at Spanhoe. Images from one CCTV camera showed the aircraft approaching the airfield boundary. Analysis of the CCTV showed that the aircraft was flying at approximately 140 kt ground speed and at around 500 ft agl as it passed through the camera's field of view.

The second CCTV camera showed the aircraft during the final manoeuvres. Only limited analysis of this CCTV was possible due to the distance of the camera from the aircraft and the camera lens optics. This analysis combined with the witness evidence suggested that the maximum possible height that G-EEEK reached during the vertical climb was 1,200 ft agl.

Aircraft information

The Extra EA-200 is a two seat fully aerobatic aircraft, designed for unlimited aerobatics. The fuselage is built from welded tubular-steel construction, and the wings, rudder and landing gear are made from composite materials. The aircraft has a 200 hp engine driving a three-bladed, constant-speed propeller.

The aircraft is fitted with a fuel tank in each wing and a centre/aerobatic tank fitted in the fuselage, in front of the main wing spar. Each interlinked wing tank has a capacity of 43 litres, with the centre/aerobatic tank containing a maximum of 36 litres. With the centre/aerobatic tank selected, the fuel system has a full negative g capability.

Aircraft examination

Fire damage to the aircraft's flying controls prevented a complete assessment of their condition immediately prior to the accident. Control continuity of the rudder controls, comprised of multi-strand steel cables and swaged fittings, was confirmed from both sets of rudder pedals rearwards to the rudder surface and no anomalies were identified.

The aileron and elevator control system consists of a steel torque tube between the front and rear control columns that is connected to a series of aluminium alloy pushrods and bellcranks that move the aileron and elevator control surfaces. The intensity of the post-impact fire had caused most of the pushrods to melt, leaving only steel rod-end bearings attached to the bellcranks. The aileron circuit bellcranks are made from aluminium alloy and these had also melted. Where aileron and elevator control circuit components were identified, their condition was assessed at the accident site and no pre-accident defects were found.

The aircraft's fuel selector valve had melted, leaving only the steel selector rod remaining. It was therefore not possible to determine whether the wing tanks or the centre/aerobatic fuel tank was selected when the accident occurred.

The aircraft's engine was disassembled which confirmed mechanical continuity of the valve train and pistons to the crankshaft. Apart from heat damage from the post-impact fire, the internal components of the engine were in good condition.

The aircraft's logbooks and technical records were examined. These showed that an annual inspection had been carried out on 1 April 2024, at 2,337 flying hours, in accordance with the aircraft's approved maintenance programme. A subsequent 100-hour inspection had been carried out on 20 June 2024, at 2,426 flying hours. The aircraft had a current Airworthiness Review Certificate and at the time of the accident the total flying time recorded in the aircraft's logbook was 2,455 hours. The engine logbook recorded that the engine had completed 1,200 hours since major overhaul.

There were no current aircraft defects recorded when the aircraft departed Fowlmere Airfield on the accident flight. As the aircraft was not recorded on SSR during the accident flight, a review of previous flights was undertaken to determine when the transponder had last been recorded. The last record of a transponder return from the aircraft in flight was on 24 March 2024, 72 flights prior to the accident flight. The aircraft operator stated that they were not aware that the transponder may have been unserviceable.

Weight and balance

The aircraft type is designed for the pilot in command to be in the rear seat. With only one occupant sitting in the rear seat, the weight and balance would have remained within the centre of gravity envelope throughout the flight regardless of the fuel load on takeoff from Fowlmere. The aircraft type also has a takeoff weight limit for aerobatics for both single and dual pilot configurations. With the estimated fuel load at Fowlmere and a single occupant, the aircraft was below the maximum takeoff weight for aerobatics at departure.

Aircraft performance

Fuel

It was not possible to be conclusive about what fuel remained in the aircraft when it reached Spanhoe as anything still present had been consumed in the fire. The aircraft departed from Fowlmere with an estimated 76 litres of fuel (20 litres in each wing tank and 36 litres

in the full centre/aerobatic tank). The manufacturer recommends the fuel selector be set to the centre/acrobatic tank for takeoff. It would then be the pilot's usual practice to use the wing tanks for the flight from Fowlmere to Spanhoe which would have likely used around 10 litres. This would have left around 15 litres in each of the wing tanks with the centre/aerobatic tank nearly full. When the aircraft is to be used for aerobatics the wing tanks must be empty. Fuel in the wing tanks can move around with significant force during aerobatic manoeuvres causing possible damage to the internal structure of the tanks, as well as generating additional gyroscopic forces.

Aerobatics

The Extra EA-200 is described as ideal aircraft on which to teach aerobatics. It is light on the controls and is stressed to +/- 10g. The POH lists the aircraft stall speed with a single pilot at the acrobatic maximum takeoff weight as 53 KIAS at 0° angle of bank and 75 KIAS at 60° angle of bank. Spins, including flat spins, are regarded as part of the aerobatic manoeuvres the aircraft is designed to perform.

The Extra EA-200 is designed to be able to spin both upright and inverted, and flat with and without power. Recovery is conventional and described as rapid. The pitch characteristics of a flat spin is with the aircraft either flat or the nose just above the horizon. A flat spin with power will tend to have a higher nose attitude and a reduced rate of descent compared to one without power due to the effects of the airflow from the propeller over the tail. With a Lycoming engine, a flat spin to the left with power would produce the slowest rate of descent which the aircraft manufacturer estimated to be between 100 - 200 ft per turn. In an upright flat spin, it is not possible to see the ground in an Extra EA-200 as there is no transparent floor panel.

Entering directly into a flat spin inadvertently is highly unlikely. Entry requires positive control inputs on the rudder, aileron and elevator. Inadvertently entered spins tend to be normal spins that may develop into flat spins. Recovery from a spin in an Extra EA-200 requires the application of opposite rudder, the power to idle with neutral ailerons and the stick to a neutral elevator position. The Pilot Operating Handbook for the aircraft states that using this technique the aircraft should recover within half a turn. Comments from pilots who have flown the aircraft type suggest a minimum of 800 ft would be required to recover from an idle power flat spin to a climb. This might be reduced if the power was on during the recovery. Information from the manufacturer estimated that a recovery using the recommended procedure from an intentional aerobatic category spin must assume a height loss of around 600 to 800 ft for the pull-out.

Meteorology

The weather situation on the day of the accident was generally settled with a light westerly or northwesterly wind with good visibility. There had been some lower cloud earlier in the day at both Fowlmere and Spanhoe which had gradually lifted. The cloudbase at Spanhoe at the time of the accident was between 3,000 and 5,000 ft amsl.

Airfield information

Spanhoe is a former second world war airfield which now operates as an unlicenced private airfield. The pilot of G-EEEK was very familiar with the airfield, having operated from there many times previously.

Several witnesses reported that it was not unusual for aircraft to conduct low flypasts or aerobatic manoeuvres over the airfield. The pilot was a member at the airfield and therefore was not required to obtain prior permission for the flight and the airfield operator was not aware that he was coming. The pilot did not have permission or approval to conduct an aerobatic display at Spanhoe.

Pilot

The pilot of G-EEEK was very experienced both in aerobatics and in the aircraft type. He was a qualified aerobatics instructor and had also competed in aerobatic competitions. He had also previously held a display authorisation. He had flown G-EEEK many times over several years.

The pilot was described by colleagues and former students as very safety conscious and thorough. They felt that it was out of character for him to attempt any low level manoeuvres outside of approved competitions or displays. They reported that he was not of a character who wished to 'show off' his aircraft or his skills. He acted as the flying school safety manager at Fowlmere.

He was travelling to Spanhoe to meet with a friend with whom he owned another aircraft. This was a reasonably regular meeting as the aircraft was kept at another airfield and they would often meet at Spanhoe to go flying either together or solo. The arrangement was usually that the friend would fly the aircraft over from its home base to Spanhoe so that they could fly it, although there was no set time arranged. It was reported that it was unusual for the accident pilot to fly to Spanhoe rather than drive over as he lived locally, and he would be required to pay for the hours on the aircraft. The pilot had been at Fowlmere during the morning to supervise a solo student and was due back to instruct that afternoon.

Possibility of incapacitation

The post-mortem did not show any evidence of any significant underlying natural disease and there was no indication of a potential medical incapacitation event. Temporary incapacitation such as that caused by positive g-forces will not leave any signs that can be seen post-mortem. The effects of positive g-forces can vary by many factors and can cause only partial incapacitation or a temporary loss of consciousness. The pilot did pull up to the vertical which would have resulted in a positive g load, this was followed by some sort of manoeuvre before the aircraft entered a spin to the left. This manoeuvre could have caused some negative g which also could have affected the pilot. Recovering from even a partial incapacitation can be disorientating.

Analysis

The aircraft struck the ground in an approximately level pitch and roll attitude, with very little forward speed. This is consistent with the aircraft either still in a flat spinning attitude, or in the very early stages of a recovery from a flat spin.

The intensity of the post-impact fire indicated that fuel was present in the aircraft's fuel tanks, although it was not possible to determine which fuel tank was selected. The propeller was rotating under power at impact, and examination of the engine did not reveal any evidence of a mechanical failure although a complete assessment of the engine was not possible due to accident damage. The severe fire damage to the aircraft's flying controls also prevented a complete assessment of their condition and continuity immediately prior to the accident. It is therefore not possible to exclude the possibility of a restriction of the flying controls.

Both the aircraft type and the pilot were capable of performing the manoeuvres seen by witnesses had there been sufficient height to allow for the recovery. CCTV analysis indicated that the height achieved during the vertical manoeuvre was a maximum of 1,200 ft agl. With between 600 and 800 ft being required to recover from the spin, this maximum height left little margin for the pilot.

The pilot had been flying aerobatics and instructing for several years and was very experienced on the aircraft. It would seem at odds with the pilot's experience to perform such manoeuvres unapproved and at a low altitude. Witnesses who knew the pilot well suggested aspects of the flight to be unusual and seemingly out of character. As an experienced pilot on type, he would have known that flying aerobatics with fuel remaining in the wing tanks was unapproved and presented additional risks to the aircraft and to any recovery. His colleagues reported that any operation outside of the regulations or aircraft approved envelope was not something they had ever observed in him.

Despite the lack of findings at the post-mortem it is possible that the pilot was incapacitated in some way which reduced his ability to make decisions or fly the aircraft either during or after the pull up. Although some deliberate movement of the controls is required to enter a flat spin in the aircraft type, it is possible that a pilot who regularly flew such manoeuvres could have completed the control movements whilst not fully conscious. The pull up to begin the manoeuvre would also have exposed the pilot to positive g-forces, followed by some negative g, either or both of which might have affected his level of consciousness.

Conclusion

It has not been possible to establish a likely cause for the accident although a number of possible causes were identified. Due to the extensive damage to the aircraft in the subsequent fire the possibility of a restriction in the controls that prevented or limited the recovery cannot be ruled out. It is also possible that any fuel in the wing tanks may have made the recovery more difficult.

Although there was no evidence found in the post-mortem, it is possible that the pilot was incapacitated to some degree which prevented him recovering the aircraft from the spin in sufficient time. Although he was an experienced aerobatic pilot, the effects of positive g and

negative g he may have experienced in the manoeuvre could have diminished his level of consciousness. It was not possible to establish why he chose to perform some aerobatic manoeuvres at low level, without approval which left insufficient height to recover.

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