ACCIDENT

Aircraft Type and Registration:	Replica Fokker EIII, G-CHFS	
No & Type of Engines:	1 Warner Aircraft Corp Scarab 145 piston engine	
Year of Manufacture:	2012 (Serial no: LAA 279-14805)	
Date & Time (UTC):	27 April 2013 at 1552 hrs	
Location:	Middle Wallop Airfield, Hampshire	
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:	68 years	
Commander's Flying Experience:	1,903 hours (of which 10 hours were on type) Last 90 days - 3 hours Last 28 days - 2 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The aircraft was taking part in a practice air display when, during a right turn, at a relatively low altitude, the aircraft began to descend, turning through an estimated two full rotations before striking the ground. It was considered probable that in the turn the aircraft entered a sideslip and developed a roll rate which could not be reversed by its wing-warping roll control system.

Background

The accident occurred during a practice air display involving a group of seven replica First World War aircraft. The group had been in existence since 1988 and had used Middle Wallop as a base for practice air displays since 1997. They had met at the airfield for such a training weekend prior to the 2013 display season.

History of the flight

The pilot of G-CHFS arrived at Popham Airfield, where the aircraft was based, at about 0800 hrs on the morning of the accident, where he met a colleague who was to fly a Fokker Triplane which was also based at Popham. They carried out pre-flight checks on both aircraft and pushed them out of the hangar before refuelling them. No problems were identified during any of the pre-flight preparations.

G-CHFS and the Fokker Triplane departed Popham together for the short flight to Middle Wallop. Five other aircraft participating in the training weekend arrived between

0800-0900 hrs. Once all the aircraft had arrived the pilots carried out a brief for about two hours, which included walking through the display sequence several times on the ground.

At 1141 hrs all seven aircraft took off from Runway 36 for their first practice. This went without incident and the aircraft landed again at Middle Wallop at 1155 hrs. The pilots debriefed the practice display and had lunch before briefing and walking through the display again for a further practice planned for that afternoon.

All the aircraft were airborne once more at 1549 hrs from Runway 36 for a second practice display. During the display, each aircraft flew in one of three allocated height blocks to ensure separation, the lowest of these being between 100-300 ft agl. G-CHFS was the fifth aircraft in the sequence to take off. It climbed, as planned, to occupy this lowest block with another aircraft, a BE2. With all the aircraft airborne and correctly positioned the display commenced with G-CHFS simulating quartering attacks on the BE2. This involved G-CHFS manoeuvring from side to side behind the BE2 whilst they flew in a southerly direction over the airfield. The pilot of the BE2 reported he was flying at a height of about 200 ft agl and a speed of about 65-70 kt during this part of the sequence.

A perimeter track on the airfield was being used as a simulated crowd line. The BE2 had already split to the left by the time that G-CHFS had reached the southern end of the airfield. G-CHFS then turned to the right to fly back up the simulated crowd line in a northerly direction. It was at an estimated height of about 200 feet when it was seen by witnesses to turn right through about 180º and then level its wings. It was then seen, by one of these witnesses, to turn again and finally align itself to fly parallel to the simulated crowd line.

Witnesses reported that after entering the final turn the aircraft continued in the turn whilst descending until it struck the ground. A pilot of one of the other aircraft in the display witnessed the turn from his position at a height of about 500 feet agl flying over the eastern side of the airfield. He reported that the bank angle seemed to remain constant whilst the nose pitched increasingly down. One of the display team who was observing the display from the ground reported that the bank angle appeared to increase whilst the aircraft's nose dropped. Another witness on the ground described seeing the aircraft in a steep descending turn 'slicing' through the air. The direction of the turn was reported as being to the left by some witnesses, and to the right by others. It was estimated that the aircraft completed two complete rotations before striking the ground in a near vertical attitude at the south-west end of the airfield. There was a significant post-crash fire. The time of the accident was approximately 1552 hrs.

Emergency response

The display team had contacted the airfield operations department to seek permission for the training weekend and provided the necessary information. The department, using a movement sheet[1], notified the fire section that a display team were visiting the airfield during

Footnote

[1] A sheet prepared by the airfield operations department providing information on aircraft visiting the airfield out of hours.

the weekend. The movement sheet contained no details about the display team's intended activities during their visit.

On arrival at Middle Wallop, the display team leader contacted the fire section to inform them that they would be carrying out up to three practice displays each day, but could not provide precise timings on when these would take place due to variables such as weather, briefings and refuelling.

On the day of the accident, the aircraft involved in the display were parked close to the fire station. Firemen on duty at the time reported hearing the aircraft start and seeing them taxi towards the airfield, although they did not know that the aircraft would be conducting a display over the airfield.

Pilots in the display, on seeing G-CHFS crash, made distress calls on the Middle Wallop ATC VHF frequency. These included requests for the fire section to acknowledge their calls. The fire station control room was busy at the time as a shift change was in progress. No one reported hearing any of the calls being received at that time on the control room radio receiver.

One of the display pilots was able to land quickly close to G-CHFS after the accident and attempted to tackle the fire with the small fire extinguisher carried in his aircraft. Another member of the team also managed to land nearby to offer assistance, but the fire was too intense for them to extinguish or attempt a rescue of the pilot.

The accident site was at the opposite end of the airfield and hidden by a drop in the ground so it was not in direct view of the fire station. However, some of the fireman saw smoke. There were occasionally fires burned in an area off the airfield in the same relative direction from the fire station and they initially thought the smoke was from another of these fires. The firemen were, however, sufficiently concerned that they treated it as an emergency, deploying a fire tender and crew to investigate at 1556 hrs. The fire station log records the fire being tackled at 1600 hrs, at about which time an air ambulance, which had been flying in the area at the time of the accident, landed at the airfield. They were then joined by the civilian fire, ambulance and police services which had been deployed in response to a 999 call from a witness on the airfield and arrived at about 1609 hrs.

Aircraft general description

The aircraft was a full-scale replica of a Fokker Eindecker EIII that was built to be as close as possible to the original design which entered military service in 1915. The plans for the aircraft were based on contemporary records and measurements of the only surviving original example, which is housed in the Science Museum in London.

The fuselage was constructed of a welded steel tube lattice braced internally with wires, whilst the wings consisted of wooden spars and ribs, steel compression struts and wire cable bracing. The tail surfaces and landing gear were made from welded steel tube. The fuselage and flying surfaces were covered with linen sealed with dope and varnish.

Figure 1

general view of the aircraft
(picture courtesy of Philip Whiteman)

The original design was fitted with an Oberursel rotary engine producing 100 hp but G-CHFS was fitted with a more modern Warner 145 Scarab radial engine producing 145 hp.

The aircraft was fitted with an all-flying fin and tailplane for yaw and pitch control respectively. Roll control was achieved by a wing warping system. Forces from the pilot's controls were transferred to the flying surfaces by a series of torque tubes and cables. The wing warping system used control cables, attached to the lower surface of the rear spar of each wing, which physically warped the wings. As cables from the pilot's control pulled the rear spar on one wing down, transfer cables attached to the top surface of each wing, via a pulley on the upper cabane strut, pulled the rear spar of the other wing up. This caused the wings to twist in opposite directions producing unequal lift and therefore roll.

The aircraft did not possess a conventional means of trimming the flight controls, although it was fitted with a variable clamp mechanism to add friction to the pitch-control movement of the control column. This was operated by the pilot by means of a lever to relieve stick loads in flight.

Accident site

The aircraft wreckage was located inside and close to the south-west boundary of the airfield. The ground marks and disruption to the wreckage indicated that the right wingtip had struck the ground first whilst the aircraft was steeply banked to the right in a nose-down attitude. The main wreckage was approximately 18 m from the first ground marking. Damage to the propeller indicated that it had been under power when it struck the ground. The fuel system was ruptured and there was an extensive post-accident fire which had consumed the forward fuselage area and most of the wing structure. The wreckage was recovered to the AAIB facilities for detailed examination.

Detailed engineering examination

The cockpit area and wing structure was severely disrupted as a result of the accident and burnt in the post-crash fire and therefore it was not possible to examine fully all aspects of the aircraft structure and flying controls, including the variable clamp mechanism. The severity of the fire suggested that significant quantities of fuel were present. However, it was possible to determine that all the primary bracing and control connections were intact. The magneto switch in the cockpit was in the 'BOTH' position. The spark plugs were of a normal colour and in good condition and the engine could be turned by hand after damaged components were removed.

Weather

The area was under the influence of an unstable northerly airflow with showers, some heavy, occurring during the day.

The automatic METAR observation for the airfield at 1150 hrs, the time of the first display, reported a northerly wind of 12 kt, good visibility, FEW clouds at 3,100 feet agl, a temperature of 8°C, dewpoint of -2°C and a QNH of 1016 hPa.

The 1550 hrs observation, covering the time of the second display, reported a northerly wind of 8 kt, good visibility, FEW clouds at 7,000 feet agl, a temperature of 9°C, dewpoint of 1°C and a QNH of 1015 hPa.

Airfield details

Middle Wallop is a military airfield used by the Army Air Corps for flying training. It is home to the Army Aviation Centre and houses a number of buildings, including aircraft hangars, workshops and various administration and accommodation blocks.

During normal operating hours, and at other times when military training is taking place, movements on the airfield are controlled by a dedicated air traffic control service. Outside these times, the airfield has no air traffic control service, although blind calls are required on the airfield VHF frequency.

The airfield has a fire station equipped to deal with aircraft fires anywhere on the airfield, as well as providing fire cover for the buildings on the estate. When military flying operations are not taking place, the fire station remains manned but at a reduced level in order to continue to provide cover for the buildings. The fire station has a control room and the primary means of notification of an emergency is by telephone. There is a direct telephone line from the air traffic control tower to the fire station which is used in the case of an aircraft accident when air traffic control is in operation.

The control room is equipped with a radio receiver which can be switched between the airfield's UHF and VHF[2] frequencies. The status of the receiver at the time of the accident could not be ascertained. The receiver is intended to provide some background information

Footnote

[2] Military aircraft normally operate on UHF, but can switch to VHF if required. Civilian aircraft normally only have the facility to operate on VHF and all the display team aircraft were equipped with VHF radios only.

on operations on the airfield and has no facility to transmit. Its existence is not mandated, so it is not officially funded and there is no formal training provided for its use, its monitoring being on an ad hoc basis.

The airfield is available to civilian general aviation by obtaining prior permission from the Airfield Manager during normal working hours. This is normally for use of the airfield during non-operational hours. The Army Flying Association (AFA) also operates a flying club with aircraft based on the airfield. Members may operate from Middle Wallop without prior permission. The display team pilots were all members of the AFA.

AFA members must adhere to the airfield's Flying Orders, Section MW2501.213.1, Paragraph d of which states:

> *'Notification of Flight. A list of known movements is to be forwarded to the fire section by stn ops at cease (sic) work each day and on Friday for the weekend. Before departure pilots are to contact the fire section to check on possible conflicting movements & inform them of flight details. Pilots are also to contact the Fire Section after landing to confirm arrival/sortie completion. Failure to do so will result in overdue action being taken.'*

Paragraph f of the same section concerns non-training, flight tests and operational tasks. Sub-paragraph 2 states:

> *'(2) The ac comd is to ensure that the fire section is made aware of the movement, specifically the departure and arrival times and consideration is to be given to deploying a fire appliance to monitor aircraft starts. The fire section is to maintain a listening watch on their receiver.'*

Visiting pilots who are not members of the AFA are provided with a comprehensive brief once permission had been granted to visit the airfield. The brief does not mention a requirement to report to the fire station on arrival or departure, although it does state that the fire section must be notified of any out of hours changes to movements. At the time of the accident the fire section had no responsibility for flight following for such flights.

Pilot's background

The pilot gained his private pilot's licence in 1984. He then gained a basic commercial pilot's licence in 1991, although in 2006 he chose to revert to the privileges of his private pilot's licence. He had an engineering background and had previously manufactured and flown other World War One replica aircraft. He conceived the idea to build a replica of the Fokker EIII in 2006 and commenced building G-CHFS in 2008.

The pilot last flew with an instructor in September 2011 when he completed a satisfactory licence revalidation check flight in a PA18. All his flying since this revalidation check, prior to air testing G-CHFS, was in a Fokker DR1 replica and a Flybaby 1A[3], both of which are

Footnote

[3] The aircraft had been built to look like a World War One Junkers CL 1.

single seat aircraft. He then flew G-CHFS between 13 September and 12 December 2012, recording a total of 15 flights over 8 hours 30 minutes in his log book. He then did not fly G-CHFS for three months until 28 March 2013 when he flew the aircraft for 55 minutes during its final air tests. He did not fly G-CHFS again until the day of the accident.

The pilot's ability, both as an engineer and a pilot, were well respected by his peers. Officials within the LAA who were aware of the pilot's background were confident he possessed the necessary skills to fly the Fokker EIII.

Medical

A post-mortem report revealed the pilot died of severe multiple injuries sustained when the aircraft struck the ground. These would have been instantaneously fatal. Toxicology revealed no evidence of carbon monoxide or any other likely contributory factors. There was no pathological evidence that the pilot had experienced a medically incapacitating event prior to the impact, although this could not be totally excluded.

The pilot was wearing a four-point harness, but the crash forces were considered to have been such that no additional or alternative safety equipment would have been likely to alter the outcome.

Airworthiness

Permit to Fly

Notwithstanding the international requirement for an aircraft to have a Certificate of Airworthiness, there are many aircraft in the recreational, ex-military, vintage and amateur-built categories that are not able to qualify for the issue of a Certificate of Airworthiness. In such cases, the CAA may issue a Permit to Fly which allows aircraft to fly within United Kingdom airspace. This document confirms that an aircraft is fit to fly having regard to its overall design, construction and maintenance. Due to the reduced airworthiness status, to ensure that an adequate level of safety is maintained, additional limitations and conditions are placed upon the operation of these aircraft.

For this aircraft, the airworthiness approval process was conducted by the Light Aircraft Association who, once satisfied, made a recommendation to the CAA for the issue of the Permit to Fly.

Light Aircraft Association (LAA)

The LAA are the principal representative body for amateur-built and vintage light aircraft in the UK and are structured as a not-for-profit association, owned its members. Airworthiness services in terms of design, construction and maintenance are provided for its 8,000 members under direct delegation from the UK's CAA.

General Approval process for new designs

A builder initially notifies preliminary design information to the LAA and, if the concept is generally agreeable, the project is allocated a number and a record of the type is opened.

As the design develops the builder is required to demonstrate that it is airworthy in a detailed dossier; usually compliance with an appropriate design code needs to be shown. A number of inspections by an LAA approved inspector are conducted as construction progresses to ensure the aircraft has been built to the design drawings and to an acceptable standard. Once complete the new design will be inspected by an LAA Design Engineer to ensure the design and construction details are satisfactory. A Permit to Test will then be issued to allow the flight characteristics to be verified. A final flight test will be conducted by an LAA Test Pilot.

Design approval process for this aircraft

The approval process for G-CHFS followed the normal process and a detailed stress analysis of the aircraft was conducted to demonstrate that the main structural elements met the requirements of design code CS-VLA. In addition, the Chief Engineer of the LAA was in regular communication with the builder and the stress engineer. This included many visits to view the aircraft as it was being constructed, to review and agree design details.

As is normal with a replica aircraft, the standard detail design practices were typical for an aircraft of its vintage. Only where experience has shown these to be unacceptable were modern features adopted in accordance with normal aviation practice. Examples of this would be the inclusion of a firewall between the engine bay and cockpit and improved wing wire bracing attachments.

Construction and Maintenance

Construction of the aircraft had been carried out to a high standard and had been inspected in stages by an LAA Approved Inspector. Following a recommendation from the LAA, the CAA issued a full Permit to Fly on 12 April 2013 and granted an exemption that allowed the aircraft not to display its registration mark. The Federal Republic of Germany had been contacted and they had informed the builder that they did not object to the aircraft carrying the period military colour scheme.

The aircraft had only flown about 11 hours since new and no maintenance was due. No defects had been recorded in the aircraft log books.

Flight test

The LAA cleared the aircraft for flight testing on 12 September 2012 for the purpose of issuing a Permit to Fly. In the absence of a specific certification basis, CS-VLA (Amendment 1, dated 5 March 2009) and BCAR Section S (Issue 5, dated 21 October 2009) were used as the basis for the tests. A number of test flights were flown between 13 September 2012 and 12 December 2012. The aircraft was not flown again until 28 March 2013 when air testing was completed. The aircraft log book records 24 flights taking place during this period totalling 10 hours and five minutes. They were flown by the pilot who had constructed G-CHFS and by a LAA test pilot, who compiled a formal flight test report on 6 April 2013.

Handling qualities

The investigation obtained copies of the notes made by the pilot after his first flight and also the flight test report carried out by the LAA. This was to confirm that the aircraft had acceptable handling and performance characteristics to allow it to gain a full LAA permit to fly.

In the first flight notes, the pilot reported that he was finding it easy to fly out of balance. Additionally, he commented that the force required to roll the aircraft was a lot greater than one would expect due to the wing warping mechanism.

In the general handling section of the flight test report it states:

> *'The second unusual lateral characteristic was a reduced level of stability produced by little dihedral effect and a tendency for large slip angles to develop. This quality was brought about by the relaxed directional stability that allowed the aircraft's nose to slice through the air if attention was not paid to keeping the slip ball centred combined with the reduced dihedral effect. In this condition the outside wing was moving faster than the inside wing, which caused a roll towards the inside wing. Care had to be taken not to allow so much roll[4] to build up that it could overpower the roll reversing capability of the wing-warping system'.*

This section of the report went on to describe the use of the control column clamp:

> *'Pitch control was very sensitive if the control column clamp was not used. The aircraft was not so sensitive that it could not be flown and landed with the clamp off but the pitch characteristics were much better with the clamp engaged. Indeed, it was possible to fly 'hands-off' for a short period (to fold maps, etc) using the clamp. The technique was to adjust the clamp to add friction to the control column to a sufficient extent to add the desired artificial 'feel' in the pitch axis.'*

The section on general handling concluded:

> *'Overall, the handling qualities of the aircraft were unusual when compared with modern types and clearly would not comply with modern Requirements (sic). However, having compared reports of the original Eindekker, it appears to be a reasonably authentic representation of how the original Type (sic) flew. Also, once experience was gained, the actual flying qualities were reasonably benign as long as the aircraft was flown within the limitations of the wing-warping system.*
>
> *Overall, the handling qualities of G-CHFS were considered acceptable for this type of aircraft.'*

Footnote

[4] The test pilot clarified that this referred to roll angle.

No limitations on the wing-warping system were defined in the report.

The comments in the report regarding the controllability of the aircraft were included in the aircraft's pilot's notes that were produced as part of the LAA's permit to fly process. These were also referred to in the LAA's operating limitations document, which stated:

> *'This aircraft does not comply with modern handling requirements and must not be flown without the pilot having familiarised him/herself with the contents of 'Pilot's Notes Fokker Eindekker EIII Replica G-CHFS 'dated 12/4/13, or in circumstances likely to result in a departure from controlled flight.'*

Weight and balance

The report contained information on the aircraft's weight and balance. It is considered that G-CHFS was within its weight and balance limits at the time of the accident.

Stalling

The flight test report stated that stall handling was reasonably benign in all configurations, including turning and accelerated stalls. The report also commented:

> *'During turning and accelerated stalls, the slip ball had to be kept central as there was a tendency for it to 'wander' if allowed. It was also possible to build up roll rates from the aircraft's slipping characteristics rather than due to its stalling characteristics.'*

Analysis

The aircraft had been constructed to a high standard and no pre-accident defects or failures were identified. Evidence suggested that the engine was operating normally at a reasonably high power setting when it contacted the ground. Evidence from the accident site supports witness reports of the aircraft in a steep nose-down turn to the right just prior to impact.

The use of the control clamp, while making a positive contribution to the handling characteristics, could have caused the aircraft to maintain a turn unless the pilot was able to make a deliberate movement to reduce the pitch input. There was, however, no means of discerning whether this had been the case from examination of the wreckage.

There was no evidence that the pilot had suffered any medical incapacitation that might have affected his ability to fly the aircraft, although it remains possible that any incapacitation was not subsequently detectable.

When considering operational aspects, the investigation found that, unless attention was paid to the slip indicator, the aircraft could easily enter sideslip without this being obvious to the pilot. Furthermore, should sideslip develop, then roll rates could develop and a roll angle achieved that could not be reversed by the wing-warping roll control system fitted to the aircraft. Flying in a practice air display with other aircraft would have exerted a number of demands on the pilot's attention. This would have been exacerbated by the pilot's lack of

recency and experience on the aircraft. The pilot had apparently been aligning the aircraft with the practice crowd line just prior to the accident and it is possible that his attention would have been outside the cockpit during the turn in order to fly the correct line. Based on the limited evidence available, this is considered the most likely scenario and one which may have led the aircraft to enter a sideslip and subsequently developing a roll which could not be reversed by the wing-warping roll control system.

Emergency response

The fire section, whilst aware of the display team's presence at Middle Wallop, did not know that the team would be performing a practice display over the airfield at the time of the accident. Whilst the display team leader had not provided exact timings of the practice displays, the proximity of the parked aircraft to the fire station made it seem self-evident to the display team that the fire section would have been aware of their arrival and departure for their various flights.

When the accident occurred, the radio calls to the military fire station were not heard. The status of the receiver at the time of the accident was not known and it cannot therefore be determined whether the messages were audible to those in the fire station control room, or whether they simply went un-noticed due to the distractions of the shift hand-over going on at the time.

The firemen were conditioned to respond to emergency call-outs by phone and the radio receiver was not routinely monitored. This reflected the stated unofficial nature of its existence, although this seems to contradict the statement in the airfield Flying Orders that the fire section maintained, when necessary, a listening watch on the receiver. The requests from the pilots that the fire section acknowledge their calls also suggests the pilots did not realise that the fire station was not equipped, nor the firemen qualified, to transmit on the airfield radio frequency.

The military fire service was delayed in responding to the crash because they were unaware it had occurred. Once they had cause for concern, after seeing smoke, they reacted quickly and that no actions by any party could have averted the fatal outcome to the accident.

Safety Actions

As a result of the accident, all out-of-hours visiting aircraft are now required to report to the fire station upon arrival and departure and the fire section conducts 'flight following' on all visiting aircraft. The Flying Orders have also been reviewed to amend references to the monitoring of radios.