ACCIDENT

Aircraft Type and Registration:	Silent 2 Electro, G-CIYA	
No & Type of Engines:	1 x FES-SIL-M100 22 kW brushless electric motor	
Year of Manufacture:	2015 (serial no: 2075)	
Date & Time (UTC):	19 October 2015 at 1457 hrs	
Location:	Husbands Bosworth Airfield, Leicestershire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Serious)	Passengers - N/A
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	66 years	
Commander's Flying Experience:	154 hours (of which none were on type) Last 90 days - 11 hours Last 28 days - 1 hour	
Information Source:	AAIB Field Investigation	

Synopsis

During the initial climb following a self-launch, the aircraft entered an incipient spin. One wing struck the roof of a farm building, before the other wing and fuselage impacted the ground. The pilot was seriously injured. The investigation did not reveal any malfunction or defect to account for the accident. Although the pilot was experienced and current in light aircraft, gliders and motor-gliders, he had not flown the aircraft type before.

The aircraft was fitted with a ballistic parachute recovery system which had not been activated. The investigation highlighted a number of issues concerning such systems which present a risk to the aircraft occupants and first responders following an accident.

One Safety Recommendation has been made.

History of the flight

The pilot collected the aircraft new from the manufacturer, and transported it by road to Husbands Bosworth. He discussed the launch options for his first flight in the aircraft with other pilots, instructors, and the deputy CFI. He had reportedly concluded that a winch launch, being quite a dynamic exercise, was not appropriate and, because the aircraft only had a belly-hook, an aero-tow was not ideal either (he was used to aero-towing using nose-hooks on other gliders). Therefore, he decided to self-launch using the electric propulsion system. On 18 October 2015, the weather was unsuitable for flight so he rigged the aircraft and only conducted taxi trials using its electric propulsion system.

On the afternoon of 19 October 2015, the weather was benign, with light winds, good visibility, and no low cloud. The pilot went to the gliding club at Husbands Bosworth and rigged the aircraft. He was assisted by another club member who had experience of gliders with electric propulsion systems. This member also ran with the wing during the initial phase of the launch.

The pilot did not subsequently recall events during the flight, and so the recollections of the other club member witness were the only available evidence. The wing-runner reported that the pilot appeared to be methodical in preparing for the flight and was capable of reaching all the controls. The flaps had been set at +1 and the electrical propulsion system appeared to operate normally. He also said that the pilot had a loose seat cushion in the cockpit, but was not sure if he sat on it, or if it was placed behind his back. Either way he did not think that it would have interfered with the takeoff.

The wing-runner described the takeoff, from a straight section of the paved northern taxiway on the airfield, as apparently normal, but stated that at about 20-30 ft agl, the pitch attitude increased to an angle which gave him cause for concern. He reported that this attitude was maintained until "perhaps" around 100 ft agl when the aircraft stalled and its left wing dropped. It then entered what appeared to be an incipient spin and one wing struck the roof of a farm building before the other wing and fuselage impacted the ground. The pilot was seriously injured, and the wing-runner, and then other club members, gave first aid until the emergency services arrived.

Although the aircraft was fitted with a Ballistic Parachute Recovery System, the system had not been activated.

The pilot

The pilot learnt to fly as part of an RAF Flying Scholarship in his younger life[1], and had taken up light aircraft flying and gliding in recent years. He regularly flew in Cessna 152s, Falke motor-gliders, and Schempp-Hirth Discus and SDZ-51 Junior gliders. Within the last 90 days he had flown 5 hours in Self Launched Motor Gliders (SLMG) and 6 hours in gliders.

As the pilot held both motor-glider and glider qualifications, he did not require any additional training to fly the Silent 2 Electro.

Takeoff technique

The Flight and Maintenance Manual contained this instruction concerning flap position for self-launch:

> *'Set the flaps at +1 position.'*

Footnote

[1] No log book of this activity was available and it was not included in the hours quoted for the pilot's experience.

The pilot was provided with a copy of the aircraft's *Flight and Maintenance Manual* and a set of *Flight notes* which, on the topic of self-launching, stated:

- *'Maintain wings level and neutral pitch during the ground run.*
- *The glider will typically lift off when the indicated airspeed of 90~100 kph (48~53kts) is reached. Don't be tempted to pull the glider off the ground prematurely.*
- *Maintain air-speed 90~100kph (48~53kts) for the duration of the climb-out.'*

Aircraft description

General

The Silent 2 Electro is a single-seat, self-launching microlight sailplane that operates in the UK under the Single Seat Deregulation (SSDR) airworthiness exemption to the Air Navigation Order (ANO).

The aircraft is constructed from carbon and glass-fibre, has a 13.5 m wingspan and a 'T' tail configuration. The flying controls, which consist of a speed brake, flaperons, rudder, variable incidence tailplane and elevator, are operated by a system of pulleys, cables and push rods. The aircraft is trimmed in pitch by the tailplane, which is coupled, by a cable, to the flap control. G-CIYA was also equipped with a release hook mounted just in front of the main wheel and was cleared for both winch and aerotow launches.

The pilot's seat, which is not adjustable, is covered with a two-piece cushion joined by a zip fastener, which is attached to the seat base and back by Velcro fasteners. On the accident flight a seat pad (cushion) approximately 380 mm square and 50 mm thick, when compressed, was found in the cockpit. The pilot was secured by a four-point seat harness and the aircraft was equipped with adjustable rudder pedals.

The canopy is attached to the aircraft by a hinge on the forward edge of the canopy frame and is locked in the CLOSED position by two locking pins located on each side of the rear part of the frame. The left locking pin operates a microswitch mounted on the inside of the fuselage that provides a 'canopy-closed' signal to the Controller in the Front Electrical-self-launch System (FES[2]).

Front Electric-self-launch System

The FES consists of two lithium polymer batteries, a controller, a FES Control Unit (FCU), a 22 kW brushless electric motor and two fixed-pitch, folding propeller blades. The electric motor is located in the nose of the aircraft and when it is not operating the propeller blades fold rearwards.

Footnote

[2] FES is also used on other gliders as the acronym for Front Engine Sustainer.

The two lithium polymer batteries are connected in series and are fitted in a compartment behind the cockpit. When fully charged the batteries have a combined capacity of 4.3kWh, at 117v, and can supply sufficient energy for the aircraft to climb for 15 minutes at more than 400 fpm and operate at cruise power for up to 60 minutes. The FCU is located on the instrument panel and provides the pilot with information on the condition of the complete propulsion system, including the batteries. The propeller rpm is set by the throttle/brake control rotary switch located at the bottom of the FCU.

Ballistic Parachute Recovery System

G-CIYA was equipped with the Magnum 300 SSP Ballistic Parachute Recovery System (BPRS). The rocket and parachute were located in a compartment behind the pilot and above the wing spars. The operating handle was located on the right side of the cockpit and had a safety pin to prevent inadvertent operation. A warning placard stating '*Ballistic Parachute Deployment Handle Emergency Use Only*' was attached to the inside of the cockpit adjacent to the operating handle. A second red warning sign stating '*DANGER MAGNUM INSIDE*' was affixed to the BPRS compartment access panel (see Figure 1).

Figure 1
BPRS warning sign

Accident site

The aircraft impacted the roof of a farm building located 20 m north of the northern taxiway at Husbands Bosworth Airfield, (see Figure 2). Ground marks and damage to the building indicate that the aircraft was in a steep nose-down attitude when the outer 4 m section of the right wing hit the roof of the building before the left wing and fuselage impacted the ground.

Figure 2
Accident site

Damage to the aircraft

When the AAIB arrived onsite, the aircraft batteries, which were undamaged, had been disconnected, the electric motor arming switch (key) was in the OFF position and the BPRS safety pin was fitted in the operating handle. In order to assist the pilot, the first responders had to disconnect electrical leads and cut some of the pitot / static pipes in order to remove the instrument panel.

The forward cockpit area and canopy had been destroyed with the electric motor having broken away from the structure. The 'canopy closed' microswitch was broken. The landing gear was in the DOWN position, but due to the damage to the control system it was not possible to establish the position of the flaps, airbrakes or tailplane at the time of the accident. The fuselage in the area of the wing attachment bolts had distorted and the main spar, wing skins and flaperons on the right wing had fractured and broken at the point where the wing struck the end of the building. The tail boom had broken approximately 0.6 m forward of the fin. Both propeller blades had failed close to the attachment bolts and detached from the electric motor. One of the blades had cut deeply into the ground and the second propeller blade was found lying on the ground close to the motor. The pitot / static system had been disrupted in several locations.

A number of the control rods and cables were damaged and had fractured. The BPRS had not been operated.

Detailed examination of the aircraft

A detailed examination of the aircraft was carried out at the AAIB facility at Farnborough where it was assessed that all the damage to the aircraft and control system occurred as a result of the impact. The pilot's harness was intact and the aircraft had been correctly rigged. There was also no evidence of pre-impact damage, or overheating of the FES or electrical systems.

The FCU and the ASI had been damaged in the accident and could not be tested. While the pitot / static system had been damaged, there was no evidence that any of the pipes had become disconnected or damaged prior to the accident.

The battery voltages were each measured as 57 V, giving a combined voltage of 114 V which is close to their maximum charge. The condition of both batteries was also checked using the data leads and test software provided by LZ-Design. This test established that the State of Charge on the batteries was 91.4% and 92.0%. The State of Health[3] was 99.8% and 99.9%.

The examination could identify no mechanical reason why the aircraft departed from controlled flight.

Flight tests

The aircraft had recently been manufactured and prior to being handed over to the pilot at the factory in Italy on 15 October 2015, it underwent two flight tests conducted by the manufacturer's pilots. The first flight test, which lasted 25 minutes, took place on 1 September 2015 using a standard factory instrument panel. The second pre-delivery flight test, which lasted 70 minutes, took place on 8 October 2015 when the aircraft was equipped with the pilot's specified instrument panel and accessories. The accident occurred during the third flight of the aircraft, which was the pilot's first flight on the type.

During the delivery process the pilot was shown and given the opportunity to rig the aircraft.

Weight and balance

A weight and balance report for G-CIYA, dated 5 October 2015, provided the following information:

Empty mass	220.17 Kg
Forward CG limit	357 mm from datum
Rear CG limit	448 mm from datum

Two ballast weights with a mass of 0.74 kg and 0.7 kg were attached to the bulkhead in the nose of the aircraft. The UK agent for the aircraft advised the AAIB that the pilot had informed him during the configuration procedure, prior to delivery, that his weight was 79 kg.

Footnote

[3] The State of Health is a measurement that reflects the general condition of a battery and its ability to deliver the specified performance compared with a fresh battery.

From the weight and balance report it was determined that mass and position of the CG during the accident flight was:

Mass	301 kg
CG	412 mm from the datum (within the CG envelope)

Deregulation of Single Seat Microlight Aeroplanes (SSDR)

On 28 May 2014 the CAA issued General Exemption E3795 to the Air Navigation Order to allow single-seat microlight aircraft to fly in the UK without being subject to the requirement to hold a valid Certificate of Airworthiness or Permit to Fly. However, this exemption does not apply to operations, licensing or medical requirements. Such aircraft are referred to as SSDR.

Ballistic Parachute Recovery System

The aircraft was equipped with a Magnum 300 SSP BPRS installed above the wing spars in the area behind the pilot. This system was fitted and armed at the factory in Italy prior to the pilot taking delivery of the aircraft.

A BPRS presents a risk to third parties who respond to an aircraft accident. This hazard was addressed for small light aircraft by British Civil Airworthiness Requirements (BCAR) Section S, which states:

> *'S 2003 General*
>
> *It must be shown by analysis or test that:*
>
> *a) the airworthiness of the aeroplane, the safety of its occupant(s) and personnel on the ground will not be degraded by the installed parachute recovery system;'*
>
> *S 2041 Markings and placards.*
>
> *d) A warning placard must be placed on the exterior of the aeroplane close to the stored energy device, which is easily distinguishable by ground personnel, warning of the potential hazard.'*

This airworthiness requirement is satisfied by adopting the recommended specification in ASTM F2316 -12[4]. However, along with other SSDR aircraft, G-CIYA was exempt from the requirements of BCAR and the only warning placard on the outside of the aircraft referred to 'Magnum'. It, therefore, may not have been apparent to first responders that a ballistic rocket was fitted to the aircraft. A warning placard, shown at Figure 3, was found in the pilot's documentation, which did appear to conform to the specification in ASTM F2316-12. However, the web site, which was in German, was for a pilot's equipment shop and provided no readily accessible information on how to disarm the BPRS. The telephone numbers were not always answered and the person answering the calls could not always speak English.

Footnote

[4] ASTN F2316 -12, Standard Specification of Airframe Emergency Parachutes.

Figure 3

Warning placard in pilot's documentation

The BPRS on the Silent 2 Electro is installed and armed with the wings removed from the aircraft and it is not possible to make the system safe with the wings fitted. In this accident the wings were damaged and the structure in the area of the BPRS was distorted such that the activating cable was pressed against the side of the fuselage. Due to accessibility it was not initially possible to establish if the trigger in the initiating unit had been partially cocked and it took several hours for the AAIB to disarm the BPRS and safely remove the rocket by cutting a hole in the side of the fuselage.

It was also noticed that there were no warning placards on the trailer that was used to store and transport G-CIYA to alert emergency services, in the event of a road traffic accident, that the aircraft in the trailer had a ballistic rocket fitted.

During an investigation into an accident involving a CZAW SportsCruiser, registration G-EWZZ[5], the AAIB made a number of observations concerning the safety of third parties following an accident involving an aircraft equipped with a BPRS. These observations included placarding, system design and the difficulty in disarming such systems. These observations led to a number of Safety Recommendations being made to the European Aviation Safety Agency[6] and the UK Civil Aviation Authority[7].

Footnote

5 AAIB Report G-EWZZ, reference EW/C2014/08/01.
6 Safety Recommendations: 2015-006; 2015-007; 2015-008.
7 Safety Recommendations: 2015-009; 2015-010; 2015-011; 2015-012.

Analysis

Overview

The witness who helped to launch the aircraft reported that the takeoff initially appeared to be normal, but the aircraft then adopted a steeper than expected pitch attitude before it reached a height of around 100 ft when it appeared to stall and enter an incipient spin to the left. The investigation could not determine why the excessive pitch attitude was maintained.

From the damage to the aircraft, and ground marks, it was established that the aircraft was in a very steep nose-down attitude when it crashed. The initial impact occurred between the outer ⅓ of the right wing and the roof of the farm building. The left wing, followed by the cockpit section, then hit the ground. This sequence reduced the force on the cockpit section, increasing the chance of the pilot surviving the accident.

Possible causes for the excessive pitch attitude

The weather conditions were benign, and the pilot was suitably qualified and experienced on both gliders and SLMG aircraft. Having considered the possible options for his first takeoff in the Silent 2 Electro, he had elected to carry out a self-launch from the paved taxiway at Husbands Bosworth. This was a viable alternative to the more dynamic winch-launch alternative, and suited the fact that he had previously aero-towed only on gliders equipped with nose-hooks.

The aircraft had successfully completed a 70-minute factory flight test eleven days prior to the accident. The pilot had also rigged the aircraft and undertaken a taxi test the day prior to the accident with no reports of any problems. The witness who assisted the pilot on the day of the accident reported that the pilot appeared to be able to reach all the controls and that, in his opinion, the cushion in the cockpit was unlikely to have moved, or deformed, in a manner that would have affected the pilot's ability to control the aircraft.

Examination of the aircraft determined that it had been correctly rigged and, outside the cockpit area, there was no evidence of a mechanical failure or control restriction having occurred prior to the accident. However, due to the damage to the cockpit area and the disruption caused by the rescue operation, the possibility that something in the cockpit had restricted the movement of the control column could not be eliminated.

The Mass and Balance were within the aircraft limitations and the flap setting of +1 was in accordance with the self-launch procedure in the flight manual[8]. The damage to the instruments and pitot / static system made it impossible to determine if the ASI had been reading correctly. However, the ASI had functioned correctly during the test flight carried out 11 days prior to the accident. Although the multi-probe had been removed while the aircraft was transported by road, there had been no disruption to any other part of the pitot / static system, all the connectors were found to be intact and there was no evidence of any pre-impact damage to any of the flexible pipes.

Footnote

[8] Flight and Maintenance Manual, Silent 2 Electro, Chapter 4.4.

The witness reported that at the start of the flight the electric propulsion system appeared to be operating normally. From the ground marks it was established that one of the two propeller blades had cut deeply into the ground, indicating that the propeller was rotating under power. The available evidence suggests that the propeller was being driven under power from the electric motor at the time of the accident.

Ballistic Parachute Recovery System

Following an accident involving a SportsCruiser, registration G-EWZZ, the AAIB made a number of Safety Recommendations to the CAA to reduce the risk to third parties responding to an accident involving an aircraft equipped with a BPRS. The Safety Recommendations and the responses from the CAA are as follows:

Safety Recommendation 2015-009

It is recommended that the Civil Aviation Authority review the requirement for the placarding of aircraft referred to in Regulation (EC) 216/2008 Annex II, fitted with a Ballistic Parachute Recovery System so that the warning placards contain information on the location of the rocket launcher and the actuating device, and can be read from a safe distance regardless of the stationary attitude of the aircraft.

The CAA responded:

'The CAA accepts this recommendation and undertakes to review the requirements regarding placarding relative to location of BRS and actuating device fitted.'

And:

Safety Recommendation 2015-010

It is recommended that the Civil Aviation Authority introduce the requirement that, for aircraft referred to in Regulation (EC) 216/2008 Annex II, the rocket launcher in an aircraft Ballistic Parachute Recovery System is fitted in a position where it can be readily disarmed following an accident.

The CAA responded:

'The CAA accepts this recommendation and will compile some Administrative & Guidance Material to BCAR S (Sub-Section K), relating to location and ease of disarming of such systems.'

And:

> **Safety Recommendation 2015-011**
>
> It is recommended that the Civil Aviation Authority introduce an information system, for aircraft operating in the UK that allows first responders and accident investigators to identify if an aircraft is equipped with a Ballistic Parachute Recovery System. This information system should include details of the type of system fitted, the location of the major components, routing of the actuator cable and the actions required to make the system safe.

The CAA responded:

> *'The CAA accepts this recommendation and will undertake a review to determine the practicality of expanding G-INFO so that owners may add details appropriate to modifications to their specific aircraft.'*

And:

> **Safety Recommendation 2015-012**
>
> It is recommended that the Civil Aviation Authority takes action to ensure that information on the risks from Ballistic Parachute Recovery Systems is disseminated to the emergency services operating in the United Kingdom.

The CAA responded:

> *'The CAA accepts this recommendation. When and if action in response to recommendation 2015-011 is in place, it will undertake to issue an Information Notice to promote awareness.'*

BPRS regulatory requirements

Unlike light aircraft that operate in the UK on an EASA Certificate of Airworthiness or a Permit to Fly, aircraft operating under SSDR are not required to conform to aircraft design standards, including those specified in ASTM F2316-12, for BPRS. While owners of SSDR aircraft are required to comply with the Air Navigation Order (ANO), it may not be obvious that Article 38 (2) and (5) of the ANO also apply to a BPRS fitted to SSDR aircraft. These articles state:

> *'(2) The position of equipment provided for emergency use must be indicated by clear markings in or on the aircraft.*
>
> *(5) All equipment installed or carried in an aircraft,…….must be installed or stowed and maintained and adjusted so as not to be a source of danger in itself ……'*

The potential risk to third parties responding to an accident involving an aircraft equipped with a BPRS is the same irrespective of the requirements under which the aircraft is designed and operated. Therefore with regards to a BPRS, SSDR aircraft should conform to the same requirements as aircraft operating on a UK Permit to Fly. Therefore the following Safety Recommendation is made:

Safety Recommendation 2016-048

It is recommended that the Civil Aviation Authority require that Ballistic Parachute Recovery Systems fitted to Single Seat Deregulated Aircraft comply with Article 38 of the Air Navigation Order and that the installation and placarding meet the same requirements as for aircraft operating on a Permit to Fly.

Safety action taken

The UK agent of the Silent 2 Electro has advised the AAIB that the aircraft manufacturer has taken action to attach the correct BPRS placards to their aircraft and trailers prior to delivery.

The BGA have also stated that they will act on this report to inform the gliding community of the potential dangers from gliders fitted with BPRS that have been involved in an accident.