ACCIDENT

Aircraft Type and Registration:	SZD-55-1, G-CKLR	
No & Type of Engines:	None	
Year of Manufacture:	1993 (Serial no: 551193056)	
Date & Time (UTC):	8 April 2017 at 1045 hrs	
Location:	Currock Hill Airfield, Northumbria	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Fatal)	Passengers - N/A
Nature of Damage:	Extensive	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	62	
Commander's Flying Experience:	18,800 hours (of which 39 were on type) Last 90 days - 1 hour Last 28 days - 0 hours	
Information Source:	AAIB Field Investigation	

Synopsis

During a towed launch, the glider was seen to climb rapidly. After disconnecting from the tow rope with a very high pitch angle, the glider rolled to the right and descended before hitting the ground in a nose-down attitude. The pilot was fatally injured.

The investigation determined that the elevator control connection had not been correctly made when the glider was rigged and this condition was not detected prior to the flight. Consequently, during the launch, the glider would have had no effective elevator control and the pilot would have been unable to control the pitch of the glider.

It was found that an historic and unapproved modification to the glider significantly increased the opportunity for mis-rigging. As a result, the European Aviation Safety Agency have taken safety action to mandate an inspection of similar gliders. In addition, one Safety Recommendation is made.

History of the flight

In the two months prior to the accident, the pilot had been conducting some work on the glider to fit some new avionics, including a transponder. This was his first flight after completing the work. He arrived at the airfield at around 0830 hrs in order to prepare and rig the glider for flight.

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He engaged the help of some club members, who were on their way to the launch point, to help him with rigging the wings of the glider. Once that was done, he drove them, in his car, to the launch point, before returning to complete the rigging of the glider. There were no witnesses to the rest of the rigging, nor to any checks which may have been carried out upon completion. Other club members reported that it was usual for the pilot to complete the rigging of the tailplane himself, and then tow the glider up to the launch point using his car.

Once at the launch point, the pilot was joined by the other owner of the glider. It was normal practice for both owners to fly the glider in turn. The pilot positioned the glider for launch at the end of the north-easterly runway, strapped in and completed the pre-launch checks, including a check for full-and-free movement of the controls with the help of the other owner. The tow line was attached to the front hook, also known as the aero-tow hook, and the launch commenced in accordance with the club procedures.

As the tug accelerated towards takeoff speed, the tug pilot became aware that there was a problem with the launch. When he looked behind, he noticed the glider was climbing rapidly above him. He then felt the tow release and the tug continued its takeoff.

Witnesses on the ground saw the glider become airborne and adopt a steep angle before they heard the crack of the tow rope releasing. The glider reached an estimated height of 100 ft, then appeared to drop its right wing and descend nose-first into the ground, coming to rest at the right of the grass strip, facing back towards the launch point. The pilot sustained fatal injuries.

Meteorology

The weather recorded at Newcastle Airport, which lies 8 nm to the north-east of the gliding site, was a light variable wind, CAVOK and a temperature of 11°C. Witnesses at the gliding club reported the same conditions with a light easterly wind.

The pilot

The pilot was an experienced former airline captain. He also had extensive flying experience in hangliders, microlights, and fixed wing aircraft. He had started gliding in 2014 and, after completing his gliding course, the pilot flew a Sport Vega glider before purchasing G-CKLR. He had completed 85 launches, all of which were at Currock Hill with 52 of those launches being in G-CKLR. He had flown for 38 hours and 44 minutes in G-CKLR before the accident flight. The pilot had not flown for the two months prior to the accident as he was completing the work on the glider.

The pilot had recently retired from commercial flying due to medical issues which meant he could no longer hold a Class One medical. One of these issues was some loss of strength and feeling in his right arm and shoulder.

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Airfield information

Currock Hill has a grass strip orientated 06/24 which is 600 m long. It is operated by a gliding club. The gliders are towed into the air using a light aircraft and a tow rope. The airfield and the accident site are shown in Figure 1.

Google Earth imagery date 17/7/17 - accessed 5 December 2017

Figure 1

Currock Hill Airfield and accident site

On-site examination

The glider had struck the ground in a steep nose-down attitude, to the right of Runway 06 and facing approximately opposite to the takeoff direction. The nose of the glider and cockpit area were severely disrupted. The seat was intact but had separated from its structural mounts. However, the harness and its attachment points were intact.

The left wing leading edge struck the ground, as indicated by a 3 m long ground mark and the right wing had detached at the root. The impact severed the fuselage structure aft of the wings, causing the base of the tail fin to strike the ground. The rudder surface did not move freely, having been forced off its pivots during the impact. The elevator appeared to be jammed in the fully-up position, having been forced upwards by the impact and maintained in that position due to the elevator control rod having been bent at the location of the fuselage break. The elevator released when the control rod was cut to facilitate removal of the wreckage; however, once released, it did not exhibit a full range of movement.

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Survivability

The glider descended with a high rate of descent and hit the ground nose-first, crushing the front of the structure completely. The pilot was wearing a parachute, however the glider did not reach a height at which this could have been used successfully. The accident was not survivable.

Recorded data

A video of the initial takeoff roll was made available to the investigation. The video commences with a right rear view of the stationary tug. The glider was not in view but was to the left of and behind the camera. The tug started its takeoff and the glider came into view on the left of the frame. The glider continued forward into the distance and pitched up. In the final video frame, the glider was approximately 15 ft above the ground with approximately 5° of right roll and 15° of nose-up pitch. The tug did not appear to have left the ground by the end of the video.

During the glider's takeoff roll, use of ailerons, rudder and airbrake were evident. When first visible in the video, the elevator is in a slight trailing edge-up position. The image resolution, thin profile of the elevator and poor contrast does not support accurate measurements of elevator deflection. No large elevator deflections were identified in the video but, as the distance between the camera and glider increased, even large deflections would have been increasingly difficult to detect.

A number of electronic items were recovered from the accident site, including an LX8080 unit which recorded data during the accident flight. It recorded a set of parameters once per second during the takeoff roll and then switched to recording once every four seconds once it met its takeoff detection criteria. The data is shown in Figure 2. The peak TAS recorded was 44 kt (82 km/h). At the last recorded data point, the GNSS (Global Navigation Satellite System) and pressure-derived altitudes indicate that the glider had a height of approximately 60 ft agl. The low sampling rate at that time makes it unlikely that the last data point coincided with the peak height reached. In addition, both the sources of altitude data could be subject to increased errors during dynamic manoeuvres.

Data recovered from the tug (Figure 2) indicates that in the four second period between the glider's last two data points, the tug, which was still on its takeoff ground roll, experienced a short period of deceleration. Thereafter the tug's acceleration was higher than that evident earlier in the takeoff roll.

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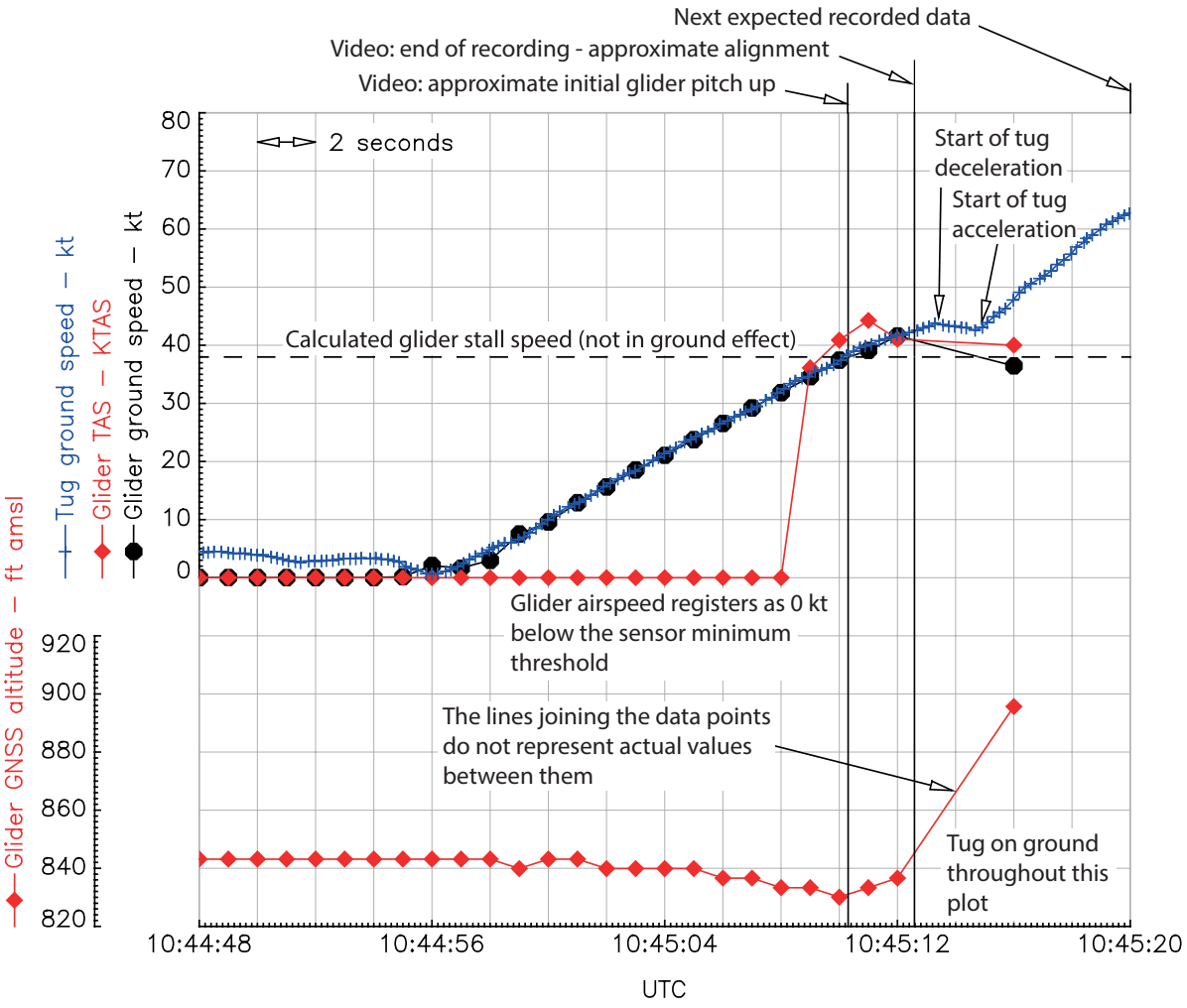

Figure 2

Recorded data from the glider and tug

Description of the glider

General

The SZD 55-1, a single-seat standard class sailplane with an empty mass of 215 kg, was designed and manufactured by Szybowcowy Zaklad Doswiadczalny (SZD) Bielsko in Poland in the 1990s. The type certificate is currently held by Allstar PZL.

The SZD-55-1 is of predominantly fibreglass construction with an elliptical wing planform. It has a retractable main undercarriage wheel and a fixed tailwheel. G-CKLR was equipped with two towing hooks, a Tost G-type hook on the undercarriage fork, used for winch launching and a Tost E-type hook under the nose of the glider, used for aero-tow launches.

The flight control systems for the aileron, airbrake and elevator are of the push-rod type, and designed to be automatically-connecting during the rigging process. The rudder, towing hooks and wheel brake control systems are operated by cables.

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Elevator control system

The elevator control system on the SZD-55-1 (Figure 3) is comprises a horizontal push-rod which runs from the control stick quadrant, throughout the length of the fuselage to the base of the tail fin, where it is connected via a bellcrank to another push-rod, which runs vertically up through the fin. At the top of the vertical push-rod, a pivoting guide mechanism, known as the elevator mechanism, couples with the elevator control hinge (elevator lever), when the tailplane is attached to the fin. A roller on the end of the elevator lever facilitates alignment by ensuring the lever engages in the U-shaped channel of the mechanism. Figure 4 shows a detailed view of the elevator lever and elevator mechanism.

The elevator control system includes a spring-trimming lever on the control stick. Pressing the lever disconnects the spring from the control system; when the lever is released the spring engages and helps to retain the control stick in the selected position.

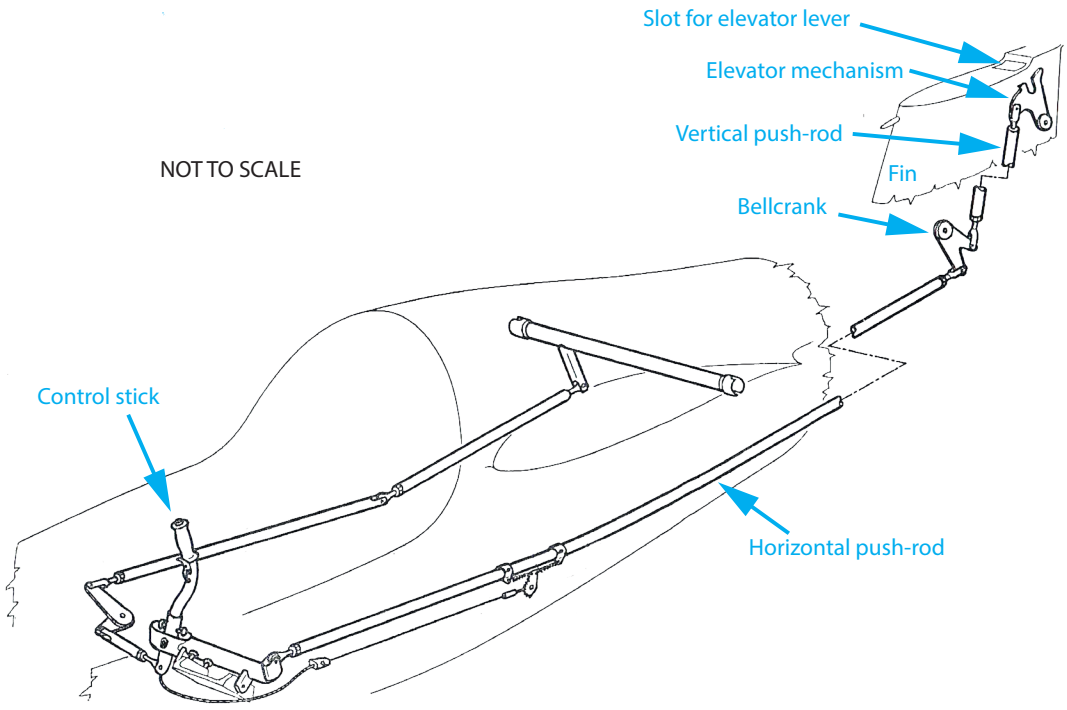

Figure 3
SZD-55-1 elevator control system

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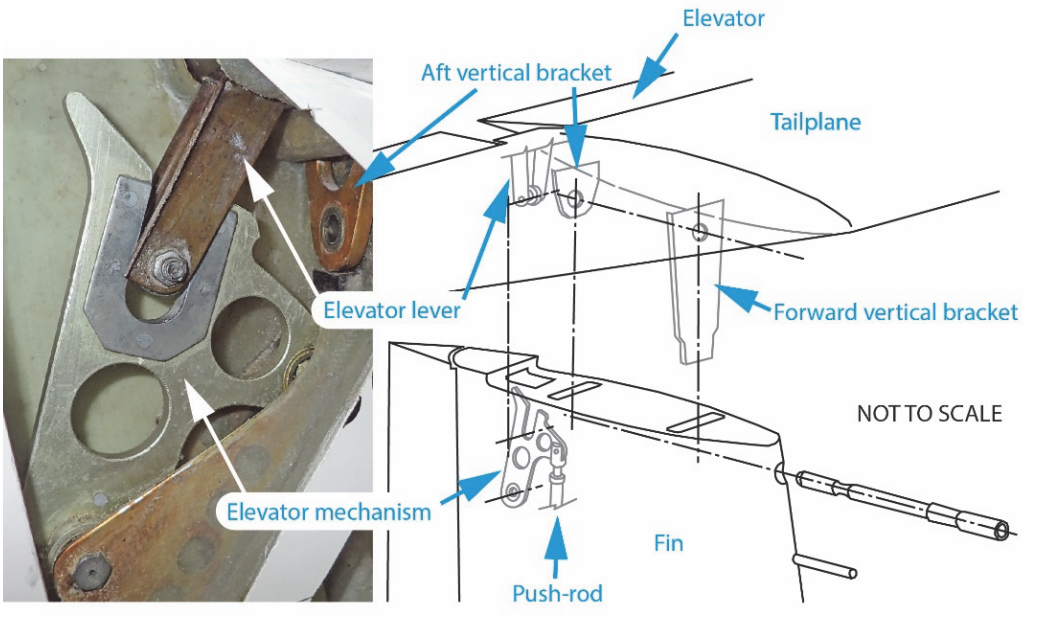

Figure 4

Normal connection of elevator lever and elevator mechanism on SZD-55-1

SZD-55-1 tailplane rigging philosophy

Gliders are generally stored in a trailer and therefore, before the first flight of each day, the glider must be rigged. Assembly of the wings normally requires two or three people and rigging of the tailplane requires one or two people.

Section 4.13 of the SZD-55-1 Flight Manual describes the assembly procedure and indicates that the wings should be assembled first and then the tailplane. It states that three people are necessary to rig the glider or, if wing supports are available, it may be accomplished by two people.

Two vertical metal brackets, on the underside of the tailplane, provide the structural connection between the tailplane and the airframe. When the tailplane is offered up to the fin, these brackets fit through two slots on the upper surface of the horizontal rib of the fin. The elevator lever, mounted at the trailing edge of the tailplane, fits through a third slot to engage with the elevator mechanism (Figures 3 and 4). The tailplane is secured in place by a long bolt, which is inserted through the leading edge of the fin.

The geometry of the tail fin and the dimensions of the slots on the upper surface of the tail fin are intended to ensure correct alignment of the structural and flight control connections, and to prevent improper connection of the elevator lever.

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With respect to rigging the tailplane, the following instructions are given in the Flight Manual. The numbers in parenthesis refer to the items labelled in Figure 5:

> ‘
> - *Put the [control] stick in the neutral position using the trimming device.*
> - *Fit the tailplane (1) on the fin. Move the stick, if necessary, to insert the lever (7) into the guide (8).*
> - *Connect the tailplane (3) and fin (4) fittings by means of bolt (5) with the assembling turn-member (9) screwed in*
> - *Screw-off the assembling turn-member and check at the final phase of screwing-off (2 threads) the efficient securing [of] the bolt against shifting out.*
> - *…….*
> - *Hold the elevator and ailerons and check the operation of the control systems under the loading.*
> - *…..’*

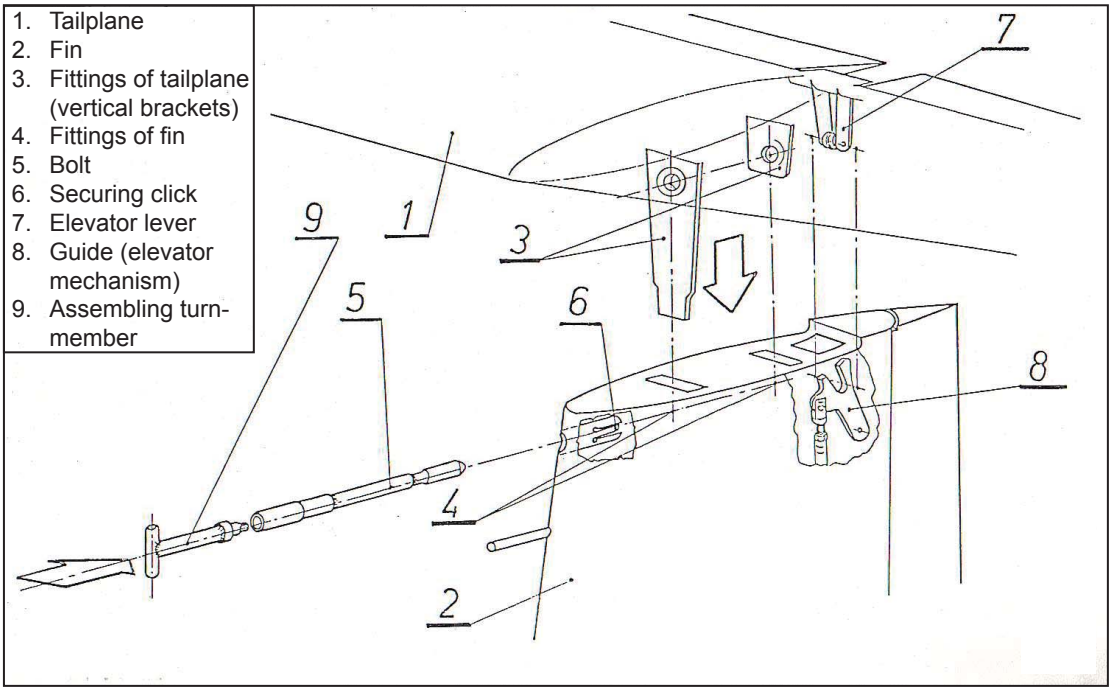

Figure 5

Amended extract from SZD-55-1 Flight Manual showing tailplane and elevator rigging

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Information from the manufacturer

The manufacturer of the glider was not aware of any previous SZD-55-1 accidents relating to elevator mis-rigging. Following this accident, it performed a trial tailplane rigging on an SZD-55-1 to identify if there was any potential for a mis-rigging condition. The manufacturer determined that if the elevator lever was not properly engaged in the elevator mechanism, it was not possible to fully rig the tailplane, even if excessive force was used. The manufacturer advised the investigation that the design features of the tail fin and tailplane, namely the shape and dimensions of the slots in the horizontal rib of the fin, the design of the elevator mechanism and the presence of the wooden stop block, prevented the possibility of a mis-rig. If the elevator lever and mechanism were not fully connected, the tailplane would not fit properly to the vertical fin, a gap would be visible and it would not be possible to insert the rigging pin.

The manufacturer advised that the trimming spring would not hold the control stick rigidly in place and would allow some movement of the mechanism to achieve alignment.

Detailed aircraft examination

The tailplane was correctly seated on top of the tail fin with no obvious gap between the tailplane and the fin. Access panels were cut in the tail fin to inspect the elevator control connection. It was observed that the tailplane structural connections were correctly made, and the securing bolt correctly inserted. However, the elevator lever was not engaged in the elevator mechanism, but was instead sitting aft of the mechanism (Figure 6).

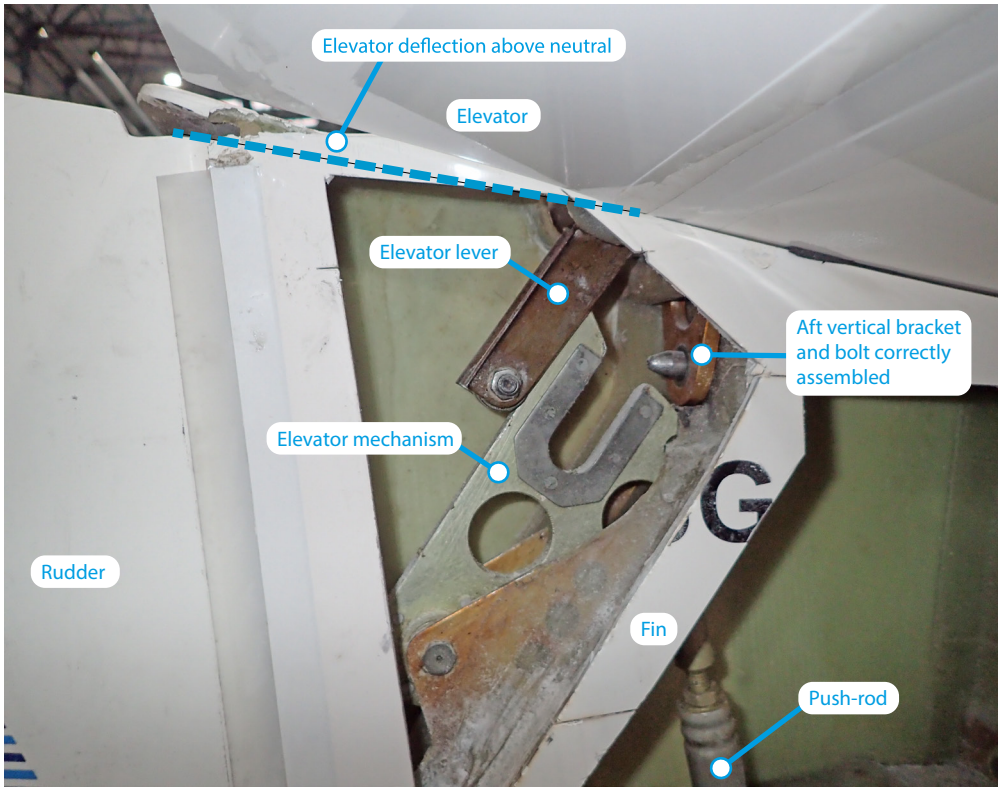

Figure 6

Position of elevator lever as found on G-CKLR
(Note: elevator lever not engaged in elevator mechanism)

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Disruption to the elevator control system, caused by the impact, meant that the control stick was no longer connected to the elevator control mechanism, and the position of the mechanism was therefore not restrained. Consequently, as shown in Figure 6, the elevator mechanism, under its own weight, is resting against a small wooden block, which forms the forward stop of the elevator control system. This corresponds to a position slightly forward of full forward control stick. In normal circumstances, control stops on a bracket at the base of the control stick limit its range of movement and, when the control stick is in the fully forward position, there should be a 0.5 mm gap between the elevator mechanism and the wooden block.

During examination of the wreckage, the horizontal elevator push-rod was moved forward and aft to simulate movement of the control stick. It was demonstrated that in this mis-rigged condition, the elevator surface could be driven upwards by moving the control stick (push-rod) aft. Forward movement of the control stick (push-rod) resulted in the elevator surface moving downwards under gravity, but only to a position above neutral and not into the normal downwards range of elevator deflection. The available range of elevator deflection in the mis-rigged condition was measured as 5º UP to 30º UP; the normal range of elevator deflection is 20º DOWN to 30º UP.

The rigging pin was removed from the fin and it came out smoothly, with no resistance. When the tailplane was removed, it was evident from examination of the horizontal rib of the tail fin, that the elevator lever slot was substantially larger than the original design dimensions. The appearance of the edge of the slot was rough and unfinished and was of uneven thickness. The manufacturer considered that the finish did not correspond to original production standard.

Figure 7 shows a plan view of the horizontal rib from the tail fin of G-CKLR compared with extracts from an engineering drawing provided by the manufacturer.

The design dimensions of the elevator slot in the horizontal rib of the tail fin should be 34 mm x 35 mm. The horizontal rib exhibits an approximately vertical step-change in profile towards its aft end. The design drawings indicate that the elevator lever slot should extend only partially up this vertical step, to a position which is approximately indicated by the dashed line in Figure 8. However, on G-CKLR this slot extends up the entirety of the vertical step and onto the upper rib cap.

De-rigging and re-rigging tests

A number of trial tailplane riggings were conducted, in various configurations, to understand how the presence of the enlarged slot on G-CKLR may have affected the rigging process.

It was noted that when the tailplane was held in a way that did not involve touching the elevator, the elevator surface would droop under its own weight and the elevator lever would hang vertically downwards. This put the elevator in the best orientation to align with the elevator mechanism. When offered up to the fin in this manner, even with the elevator mechanism in the fully forward position, it was possible to rig the elevator controls correctly.

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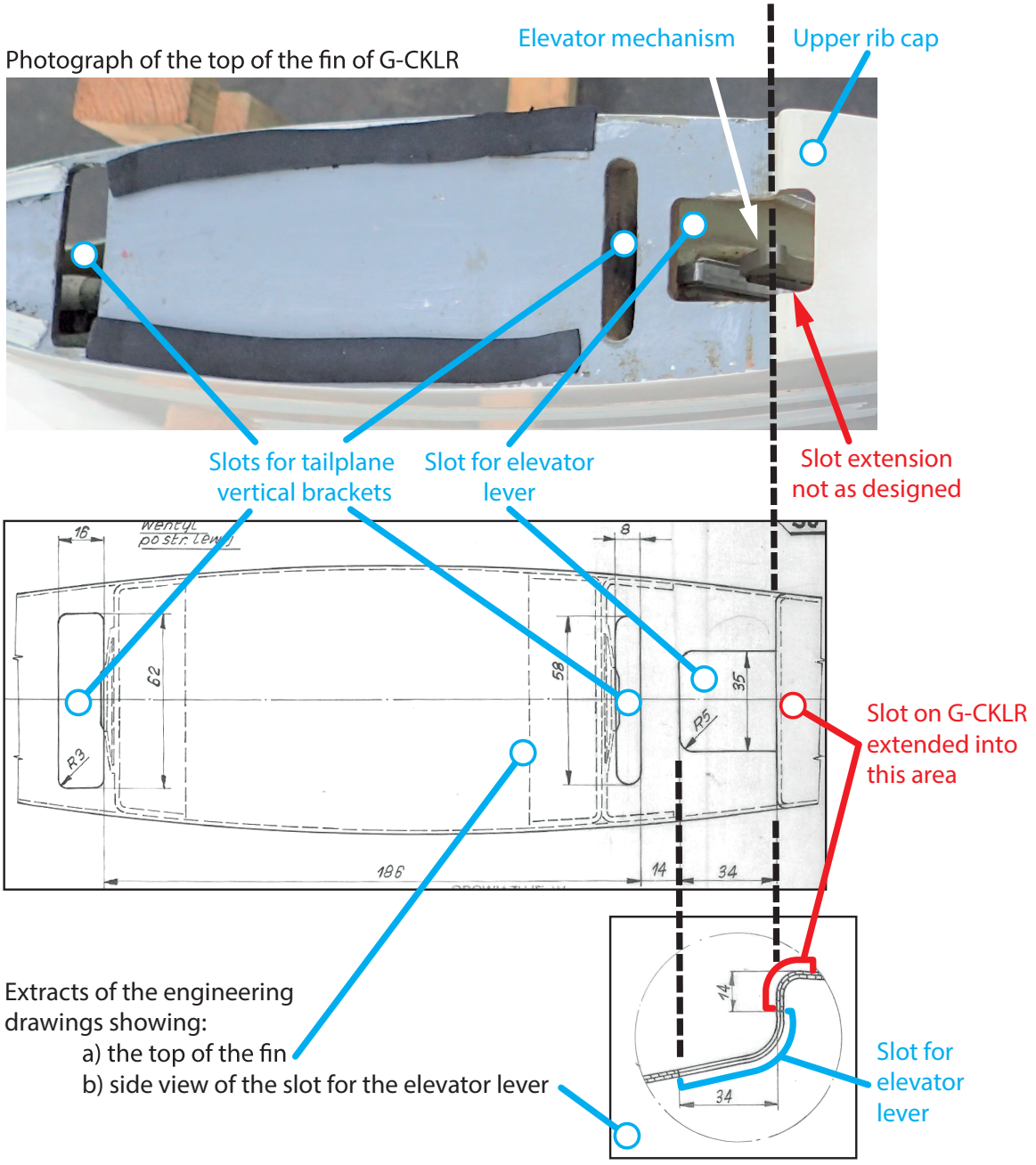

Figure 7

G-CKLR tail fin horizontal rib comparison with extracts from engineering drawing showing design dimensions

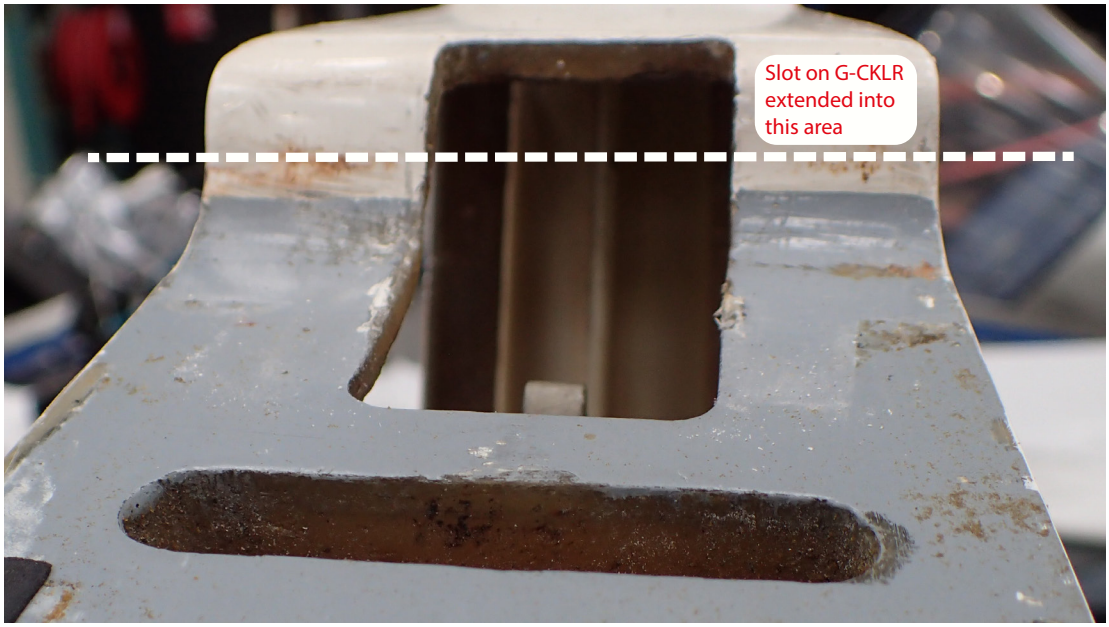

Figure 8

Rearwards view of elevator slot in G-CKLR's tail fin

If the tailplane was offered up to the fin with the elevator surface in the fully-up position, such as might occur if those rigging it held on to the elevator trailing edge, the shallow angle of the elevator lever caused it to foul against the aft edge of the slot, preventing it from entering the slot.

However, with the elevator mechanism in the fully forward position, if the elevator was held in a range of intermediate positions, the angle of the elevator lever was such that it could very easily and with no resistance enter the empty space behind the mechanism, creating the mis-rigging condition observed following the accident.

It was noted that when attempting to rig the tailplane single-handedly, it was difficult to do so without touching the elevator surface, and it was more convenient to position the tailplane with one's palms under the tailplane and one's thumbs resting under the elevator. This slight upward force would place the elevator in an intermediate position.

When the tailplane was rigged with the mechanism held in a position corresponding to a neutral control stick position, it was not possible to mis-rig the elevator controls because the position of the mechanism prevented the lever entering the empty space behind the mechanism.

In summary, these tests demonstrated that with the enlarged slot, a mis-rigging condition could occur when the elevator mechanism was in a forward position and the tailplane was held such that the elevator was in a slightly up position during rigging.

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Pilot rigging experience

All the pilot's gliding in G-CKLR took place from Currock Hill. Based on logs from the gliding club, the pilot had flown a total of 52 flights in G-CKLR on 41 separate days. The glider was stored in a trailer and was rigged prior to each day's flying. Therefore the pilot would have been involved in the rigging of G-CKLR a minimum of 41 times prior to the day of the accident; the most recent being on 04 February 2017, and, prior to that, on 10 December 2016.

British Gliding Association (BGA) publications

The BGA is the governing body for the sport of gliding in the UK and, among other things, is responsible for managing training standards and ongoing airworthiness of the UK glider fleet.

The BGA publishes a Safety Briefing Leaflet '*Is your glider fit for flight?*' which aims to highlight the importance of preparing gliders correctly for flight, offer guidance on how to do so and indicate some of the glider types and mechanisms that are vulnerable to rigging errors. The leaflet states:

> *'Rigging errors, and other errors and omission in preparing a glider for flight, are frequently caused by interruption, distraction, forgetfulness, and making unwarranted assumptions.'*

Further, it states that, for a glider without automatic control connections, it is essential for positive control checks to be carried out every time it is rigged, because this can reveal connections that have only partially been engaged. It describes the positive control check as follows:

> *'Taking care not to apply excessive force, each control surface should be restrained while an attempt is made to move the control, and the direction of motion checked. It only takes a couple of minutes for a helper to advise the rigger whether movement of the cockpit controls generates the correct responses at the control surface.'*

The leaflet describes a number of incidents where gliders have launched with elevators unconnected or incorrectly connected and identifies some glider types that are vulnerable to mis-rigging; the SZD-55-1 is not one of the types listed.

The BGA require that all gliders operating under its remit are subject to a Daily Inspection (DI) prior to flight. Typically, the DI is recorded in a DI book, which the pilot signs to indicate it has been completed. The tasks required to be completed during a DI are described in BGA publication '*Generic Maintenance Programme',* Issue 1 revision 2 19/02/2013, Section 2, page 2-2. Item 5 of the DI includes the requirement to:

> *'Check flying controls for operation and sense. Perform positive control check.'*

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Other SZD-55-1 glider examinations

The AAIB examined one other UK-registered SZD-55-1 in order to inspect the geometry of the slots on the horizontal rib of the tail fin. The slot for the elevator lever appeared to have been marginally enlarged, but not to the same extent as that on G-CKLR. The forward slot also appeared to have been enlarged. The owners of the glider had not been aware of this.

At the AAIB's request, the BGA inspected a second UK-registered SZD-55-1; the elevator slot appeared to have been marginally enlarged, but not to the same extent as that on G-CKLR.

G-CKLR maintenance history

Previous maintenance history

The previous owners, a two-person syndicate, purchased the glider in September 2005 from a sales agent who had acquired it in France, and did the necessary work to transition it to the UK register. They first flew the glider in February 2006 and sold it to the accident pilot in March 2015.

The lead owner in the syndicate confirmed to the investigation that no work had been carried out on the elevator control system or fin during the period in which he owned the glider; nor was he aware of any previous modifications performed in these areas. This situation was reflected in maintenance records. In addition, he stated that he had never encountered any difficulties rigging the tailplane or possible mis-rigging conditions.

In April 2006, not long after it was purchased by the previous owners, the glider was damaged while landing-out in a field and was sent to a facility in Poland for repair and replacement of the right wing. In a photograph taken in July 2006 while this repair was being carried out, the enlarged elevator lever slot in the horizontal rib of the tail fin is clearly visible, indicating that it had been modified prior to this point.

Prior to being brought to the UK, the glider had been owned and operated since new by a gliding club in France. A review of the maintenance records from this period did not reveal any reference to enlargement of the elevator lever slot in the horizontal rib of the tail fin. In 2003, G-CKLR was the SZD-55-1 fleet leader in terms of flight hours and, approaching the original design life of 3,000 flight hours, a life extension inspection was carried out in France by the original designers of the SZD-55-1. A review of records from that inspection did not reveal any remarks about observed deviations from the original design.

Recent maintenance history

The accident pilot purchased the glider in March 2015. Between January and April 2016, the glider had undergone repairs after it sustained damage when its trailer was blown over in a storm. The last annual inspection was carried out on 5 April 2016, and the next was due on 25 May 2017.

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At the time of the accident the glider had accumulated 3,634 flying hours over 1,449 launches. Prior to the accident flight, the glider had last been flown during a 32-minute flight in February 2017. Between then and the date of the accident, the pilot had taken the glider to his home where he had carried out extensive work on it, including fitting a new transponder and radio together with the associated wiring and replacing some other wiring.

On 2 March 2017, a BGA Inspector who had agreed with the pilot to perform the upcoming annual inspection in May 2017, visited the pilot at his home to familiarise himself with the glider and carry out part of the annual inspection while it was disassembled. During that visit he took a number of photographs of the glider which show that the seat and upper instrument panel had been removed. The new transponder had been fitted but neither the transponder antenna nor the new radio had been fitted. The pilot asked the Inspector to look at the installation of the transponder. The cockpit trim and floor had also been removed such that the base of the control stick and its connections to the aileron and elevator control runs were exposed. The Inspector also collected the glider log book and technical manuals from the pilot, in preparation for doing the annual inspection.

A number of weeks later, while at the gliding club, the pilot mentioned to the BGA Inspector that when installing the LX8080 in G-CKLR he had incorrectly connected the power leads and damaged the unit. In the week leading up to the accident, the pilot had had to cancel a planned week's gliding at another airfield as he was still waiting for the replacement LX8080 to arrive.

A member of the gliding club reported a conversation with the pilot on 2 April 2017, in which the pilot mentioned that he was doing some work on the control surfaces and linkages. The club member asked him if he was a BGA Inspector, because his own understanding was that any work done on the flight controls must be supervised by a BGA Inspector, and be subject to a duplicate inspection. The pilot's response suggested that he was not concerned by this aspect as it was only he and the other co-owner who flew the glider. He did not specifically mention what controls he was working on but the club member advised him that he should get someone to supervise the work or to do it for him.

The pilot brought the glider in its trailer to the gliding club on the evening of 5 April, in preparation for flying during the coming weekend. A friend indicated that, during a phone conversation on 6 April 2017, the pilot said he was still waiting for some parts for the glider to arrive.

Following the accident it was noted that none of the recent work performed on the glider by the pilot, nor any elements of the inspection performed by the Inspector had been documented in the glider's log book, so it was not possible to determine exactly what work was carried out. The co-owner of the glider was not aware of any work having been done on the flight controls by the pilot. No current DI book was found for G-CKLR.

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Pilot-owner maintenance

BGA Airworthiness and Maintenance Procedures (AMP 2-1) '*Pilot Owner Maintenance*', Version 1.2, effective date 1st October 2016, describes pilot-owner maintenance tasks which are permitted to be carried out under the UK ANO and EU Regulation 1056/2008 (Part M) and states that any such work should be documented via log book entries.

> *'The pilot-owner may carry out simple visual inspections or operations to check for general condition and obvious damage and normal operation of the airframe, engines and components.*
>
> *Maintenance tasks shall not be carried out by the pilot-owner when the task:*
>
> *i. is critically safety related, whose incorrect performance will drastically affect the airworthiness of the aircraft or is a flight safety sensitive maintenance task and/or;*
>
> *ii. requires the removal of major components or major assembly unless otherwise specified in the flight manual as a pilot task and/or;*
>
> *……..'*

With respect to some of the maintenance which was recently performed on G-CKLR, AMP 2-1 describes the following permitted glider pilot-owner maintenance tasks:

> *'Communication devices:*
>
> *Remove and replace self-contained front instrument panel mount communication devices with quick disconnect connectors.*
>
> *Navigation devices:*
>
> *Removal and replacement of self-contained, front instrument panel mount navigation devices with quick disconnect connectors.….excluding transponders ….*
>
> *Wiring:*
>
> *Installation of simple wiring connections to the existing wiring for additional equipment such as variometers, flight computers but excluding communication and navigation systems.'*

With regard to flight controls, AMP 2-1 describes the following permitted glider pilot-owner maintenance tasks:

> *'Flight controls:*
>
> *Measurement of free play in the flight control systems including minor adjustment by simple means.*
>
> *Measurement of the control system travel without removing the control surfaces:*
>
> *Control stick removal and reinstallation where provision for quick disconnect is made by design.'*

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Analysis

Introduction

From the examination of the aircraft, it is evident that when the glider was rigged prior to the accident flight, the elevator lever did not correctly engage in the elevator mechanism but instead entered the empty space behind the mechanism. The mis-rig was not identified prior to flight.

In this condition, while the glider was on the ground prior to flight, the elevator surface would have moved upwards when the control stick was moved aft. Forward movement of the control stick would have resulted in the elevator surface moving downwards under gravity, but only to a position above neutral.

During the takeoff, airflow across the elevator's surfaces would have caused it to move upwards and this movement would have been entirely independent of control stick position. Consequently, during the launch, the pilot would have had no effective elevator control in either direction and therefore would have been unable to control the pitch of the glider.

Design of the elevator control connection

The SZD-55-1 was designed with automatically-connecting flight controls. The design geometry of the elevator slot on the horizontal rib of the fin was specifically intended to limit the angle at which the elevator lever could be inserted, in order to facilitate correct and automatic alignment with the elevator mechanism and to prevent the possibility of a mis-rig. In order to place the elevator mechanism in the ideal position to receive the elevator lever, the rigging instructions in the SZD-55-1 Flight Manual required the control stick to be in the neutral position. However, the manufacturer did not consider the control stick position to be critical to the success of the rigging procedure because the profile of the mechanism and the presence of the roller on the end of the elevator lever, would ensure that any minor mis-alignment would be rectified by the roller rolling down the face of the mechanism and into the U-shaped channel. In addition, as per design intent, if the elevator lever and mechanism were not fully connected, the tailplane would not sit properly on the vertical fin and it would not be possible to insert the rigging pin.

Effect of the enlarged elevator slot

The enlargement of the elevator slot on G-CKLR removed one of the designed-in protections against mis-rigging and allowed a situation where the elevator lever could be inserted into the slot in a range of possible angles, effectively making the control stick position much more critical to the success of the rigging. Testing showed that the presence of the enlarged slot, when combined with a forward control stick position and a minor upwards deflection of the elevator surface during rigging, created a situation where the elevator lever could easily, and without resistance, enter the void behind the mechanism rather than correctly engaging with the mechanism. Furthermore, in this condition, the tailplane would have seated correctly on the top of the tail fin, with no obvious gap, and the rigging pin would have been easy to insert. This condition would not have been visually evident to the pilot. In normal circumstances, without an enlarged elevator slot, the first indication

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of any potential elevator control mis-rig would be that the tailplane did not properly seat on the fin and it would not be possible to insert the rigging pin.

Tailplane rigging on the day of the accident

While the presence of the enlarged elevator slot significantly increased the potential for an elevator mis-rig to occur, the investigation determined that the enlarged slot had been present since at least July 2006. The owners of G-CKLR before the accident pilot were not aware that the slot had been enlarged, and therefore there is no reason to believe that the accident pilot or co-owner could have been aware either. However, the glider had been rigged successfully many times since 2006, both by the previous owners and on at least 41 occasions by the accident pilot / co-owner, without a mis-rig occurring. It is important therefore to explore what might have been different on the day of the accident.

The accident occurred on the first flight following extensive maintenance being carried out on the glider by the pilot. It was not possible to determine the full extent of the work performed by the pilot as it was not documented in the technical log, but it is known that the work included the installation of a new transponder, radio, associated wiring and the replacement of some other avionics units. Photographs taken during the work showed that significant disassembly of the cockpit was required to carry out this work. The co-owner was not aware of any intent by the pilot to conduct work on the flight controls, however one witness recalled a conversation with the pilot in which the witness believed he clearly expressed his intent to do so. Examination of the wreckage did not reveal any obvious indications that work had been carried out on the elevator control run, but the possibility that the pilot had adjusted the elevator control run or control stick in some way which subtly changed the position of the elevator mechanism during rigging, could not be ruled out. However, this in isolation would not have caused the mis-rig but could explain why the outcome of the rigging on the day of the accident was different from previous occasions.

The pilot was keen to get airborne and test the new equipment he had fitted to the glider. He arrived at the gliding site in good time to rig his glider and prepare for the launch. During the rigging, the pilot left the glider to perform another task before returning to conclude the process. The BGA Safety Briefing Leaflet '*Is your glider fit for flight*?' highlights that interruption, distraction and forgetfulness are key factors in rigging errors. The pilot interrupted his rigging process with the best of intentions yet, in doing so, the risk of not completing the process, or introducing errors, increased. However, it is not possible to determine whether this was a factor in this accident.

There were no witnesses to the final part of the rigging process and, although other members of the club suggested that it was the pilot's normal practice to complete this task alone, the presence or help of another party could not be ruled out. Rigging and de-rigging tests conducted on G-CKLR during the investigation showed that, with the control stick in a forward position the elevator lever could easily enter the empty space behind the elevator mechanism if there was a small amount of upwards deflection on the elevator when the tailplane was placed on the fin. It was demonstrated that this situation could occur if those rigging the tailplane placed a hand on the elevator while positioning it on the

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fin. Furthermore, when single-handedly rigging the tailplane, the manner in which a person holds and positions the tailplane to align it with the fin, may increase the likelihood that there would be some upward force on the elevator, for example, if their thumb was resting on the underside of the elevator.

Having only flown the glider once in the preceding four months, it is possible that the pilot was less practised in the rigging process. This may explain why the control stick was not in the neutral position at the time of rigging. Furthermore the pilot's medical condition which resulted in a loss of strength to his right arm and shoulder may have affected the manner in which he was able to hold and position the tailplane, if doing so alone.

Opportunities to detect the mis-rig

The elevator lever and mechanism are not visible once the tailplane has been fitted. Therefore, the only opportunities to detect the mis-rig condition once the rigging was complete, would have been during a positive control check, during a full-and-free check of the controls prior to flight, or identifying a problem with the elevator feel during the takeoff roll.

The SZD-55-1 Flight Manual rigging procedure required that, upon completion of rigging, the elevator and ailerons were held to *'check the operation of the control systems under loading'*, which is, in effect, equivalent to a positive control check. The absence of any witnesses to the rigging of the tailplane, or to any checks which the pilot may have carried out upon completion, meant it was not possible to establish if, or how, a positive control check was performed by the pilot. However a number of gliding club members, including the co-owner, stated that the pilot was normally very careful about checking the glider. A pilot alone may not be able to determine, by moving the control stick, whether or not the elevator is properly connected. An effective positive control check would have required two people: one to move the control stick forward and aft, and the other to physically resist the movement of the control surface, in this case the elevator. A correctly executed positive control check should have identified, prior to the accident flight, that the elevator controls were not properly connected.

While conducting the full-and-free check of the flight controls at the launch point, the pilot would not have felt any unusual resistance to the movement of the control stick, however he would not have achieved a full range of aft control stick movement. Having flown the glider only once in the preceding four months, the reduced range of control stick movement may not have been immediately obvious to the pilot. In this case, identifying the mis-rig would have relied upon an observation that the range of movement of the elevator surface was incorrect, rather than that the surface did not move at all. The mis-rig was insidious in that the elevator would have seemed to move with the control column in the correct sense, yet it would not have deflected down past the neutral position as the control column was pushed forward. Casually observed by someone at the launch point, the elevator movement might have seemed normal.

During the takeoff roll the pilot would have been concentrating on keeping the glider straight and level, then retracting the speed brakes once adequate aileron control was

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felt. The problem would probably not have been noticeable until the airspeed of the glider reached the point at which the elevator would normally become effective. The mis-rig resulted in an increasing pitch attitude over which the pilot had no control, even with full forward control stick. It would have taken some time to realise that his control inputs were having no effect, and another period to try and work out why. The cognitive recognition that there was an issue, and the mental processing time to diagnose the situation and release the tow rope, would have exceeded the time available before the glider was in an irrecoverable situation.

Recorded data

During the tug's takeoff roll it had a brief period of deceleration. This was followed by the tug accelerating faster than it had during the initial part of the takeoff roll. The tug maintained power throughout the takeoff, therefore this would be consistent with significant drag being generated by the glider pitching up until the tow rope was detached, leaving the tug with a nett reduction in drag.

Pilot-owner maintenance

The work performed by the pilot to install the transponder and associated wiring did not come under the permitted tasks for pilot-owner maintenance and would have required inspection and release to service by a BGA Inspector prior to flight. However, this did not have any bearing on the accident.

Had any work been undertaken on the flight controls, other than that listed in BGA publication AMP 2-1 '*Pilot Owner Maintenance*', it would have required inspection and release to service by a BGA Inspector prior to flight.

Enlargement of the elevator slot

It was not possible to determine exactly when, or why, the elevator slot was modified as there was no record of this in the glider's technical records. There is no manufacturer-approved modification or repair scheme for the elevator slot, as its geometry is considered critical to the successful rigging of the elevator controls. The enlargement of the slot on G-CKLR can therefore be considered as an unapproved modification.

Photographic evidence showed that the slot enlargement had taken place at some point before July 2006. The most recent previous owners were unaware of any such modification, and there is no evidence to suggest that this work was performed during their ownership. In 2003 the glider was inspected in France by a team from the original designer, for the purposes of extending the design life of the glider. The manufacturer reviewed the records from that inspection and advised the investigation that they did not contain any reference to modification of the elevator slot, or any other deviations from the original design, but it is not clear whether this area would have been specifically inspected during the life extension inspection.

During repeated rigging and de-rigging the edges of the slot can become damaged by the elevator lever resulting in scratches, dents and paint removal. It is therefore possible that

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the slot may have been enlarged to remove such damage. However, such a repair is likely to have resulted in minimal removal of material. Given the extent of the enlargement on G-CKLR, it is more reasonable to conclude that the reason for enlarging the slot was to make the tailplane rigging process easier.

The potential for mis-rigging the elevator would have existed since the elevator slot was enlarged. But, as the immediately-previous owners and the accident pilot/ co-owner were unaware that the slot had been modified, they would have assumed that the G-CKLR continued to benefit from the original design features which were intended to assure automatic connection of the elevator controls and prevent a mis-rig situation. The unapproved modification to the elevator slot remained a latent condition until this accident. One other SZD-55-1 glider in the UK fleet inspected by the AAIB, also appeared to have a marginally enlarged elevator slot, of which the owners were unaware. These findings indicate the possibility that such modifications may have historically been considered acceptable among glider owners.

Safety action to be taken

Given the criticality of the geometry of the elevator slot in assuring automatic connection of the elevator controls in the SZD-55-1, the European Aviation Safety Agency (EASA) has indicated its intent to issue an Airworthiness Directive to mandate a fleet inspection of the SZD-55-1 glider, and other types, where applicable. The AD is intended to verify that the dimensions of the slots in the horizontal rib of the tail fin are within design dimensions.

BGA rigging guidance

The BGA Safety Briefing Leaflet '*Is your glider fit for flight*?' describes the actions required to carry out a positive control check, however it indicates that such checks are only required for gliders which do not have automatically-connecting controls. Separately, the BGA require a DI to be carried out prior to flight for all gliders, which includes the requirement to perform a positive control check. The SZD-55-1 was designed with automatically-connecting controls, however the enlargement of the slot in G-CKLR's tail fin horizontal rib removed one of the key design features intended to assure automatic connection of the elevator controls and prevent the possibility of mis-rigging.

It was not established if, or how, a positive control check was performed by the pilot of G-CKLR after completion of its rigging. However, the guidance in the BGA Safety Briefing Leaflet could be interpreted to mean that these checks are not required for gliders with automatically-connecting controls. The following Safety Recommendation is therefore made:

Safety Recommendation 2018-004

It is recommended that the British Gliding Association review its policy on the need for positive control checks on gliders with automatically-connecting controls and, where appropriate, amend its relevant publications including the Safety Briefing Leaflet entitled *'Is your glider fit for flight?*'.

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Conclusion

The SZD-55-1 glider was designed with automatically-connecting elevator controls, and the design includes features intended to prevent the possibility of a mis-rigging condition. An historic modification which enlarged the elevator slot on the tail fin of G-CKLR, degraded the protections of these design features and created a situation whereby the elevator connection could potentially be mis-rigged without any visible means of detecting it. On the day of the accident, the elevator connection was mis-rigged and this condition was not detected before flight. Consequently, during the accident flight, the pilot had no effective elevator control and was therefore unable to control the pitch of the glider.

The EASA intend to issue an Airworthiness Directive to mandate an inspection of the SZD-55-1 glider, and other types, where applicable, to verify that the dimensions of the slots in the horizontal rib of the tail fin are within design dimensions.

A positive control check could have identified the mis-rigged condition. Guidance material published by the BGA suggests that positive control checks, which are intended to detect control mis-rigging, are not required to be performed on gliders with automatically-connecting controls. Therefore, one Safety Recommendation has been made to review and, if appropriate, amend this guidance.

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