ACCIDENT

Aircraft Type and Registration:	Escapade, G-CGNV
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2011 (Serial no: LAA 345-14901)
Date & Time (UTC):	14 November 2021 at 1204 hrs
Location:	Breighton Airfield, Selby, North Yorkshire
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 (Aeroplanes)
Commander's Age:	66 years
Commander's Flying Experience:	945 hours (of which 4 were on type) Last 90 days - 9 hours Last 28 days - 3 hours
Information Source:	AAIB Field Investigation

Synopsis

At an early stage in the takeoff G-CGNV's pilot reported a problem with his seat. Eyewitnesses saw the aircraft climbing in an unusual attitude. Shortly after the aircraft lifted off it had significant left bank and was yawing and drifting to the right. At approximately 180 ft agl, the aircraft rolled left and departed from controlled flight, descended steeply, and struck the runway abeam the control tower. The aircraft sustained major disruption and the pilot was fatally injured.

The pilot flew with his seat set fully forward but the seat was at its rearmost position when the aircraft struck the ground. The evidence indicated that, due to misalignment, the seat adjustment pin had not been correctly located in one of the holes in the adjustment rail and therefore the seat had not been securely locked in the fully forward position. The seat adjuster backup strap, intended to prevent rearwards seat movement in case of pin failure, was not tightened. The exact cause of the misalignment of the seat pin and adjuster rail is not known.

The investigation considered it most likely that the accident resulted from the pilot's seat sliding backward, thereby compromising his ability to maintain effective control of the aircraft.

Three Safety Recommendations were made in AAIB Special Bulletin S3/2021, published on 14 December 2021.

History of the flight

The pilot had flown the aircraft to Breighton Airfield from Rufforth (East) Airfield during the morning of Sunday 14 November 2021 to attend a remembrance service. After the service at Breighton he boarded G-CGNV for the return flight and started his takeoff from the Runway 10 threshold. Witnesses recalled that at some stage during the takeoff the pilot made a radio call on the Breighton Radio frequency indicating that he had a problem with the seat and was returning to the airfield to land. Eyewitnesses, including several pilots, reported that immediately after lifting off the aircraft began to climb at an uncharacteristically steep angle and in an unusual attitude with the engine sounding like it was "working hard."

The aircraft initially climbed left wing low with right yaw which generated significant sideslip and its flightpath diverged to the right of the runway. CCTV imagery corroborated eyewitness accounts. The aircraft reached approximately 180 ft agl at which point the left wing dropped and the aircraft departed from controlled flight and descended steeply, striking the runway abeam the control tower.

The aircraft sustained major disruption during the impact and a fire ensued. Airfield staff were quickly on scene and the fire was extinguished within one minute. The pilot was fatally injured.

Accident site

The aircraft had struck the grass runway adjacent to the airfield control tower causing severe disruption to the nose and cockpit. Two of the three propeller blades had broken off and were found a short distance from the aircraft. Both fuel tanks had split, and a small amount of fuel had remained in the left tank. There was no fuel in the right tank and there was evidence of fire on both tank structures.

Both wings were separated from the aircraft by the emergency services as authorised by the AAIB. Continuity of all the flying controls was demonstrated at the accident site. The throttle control was pushed fully in at its maximum power setting. The aircraft battery was found lying near the cockpit outside of the aircraft. It had dislodged and broken out from its wooden tray and Velcro® strap. The positive and negative terminals had detached from the battery and their remains were left on the cables.

The rear section of the fuselage was partially separated from the cockpit. The firewall and instrument panel were disrupted, and the majority of switches and instruments were damaged. There was evidence of fire damage in some areas within the remains of the cockpit and fire wall area.

The cockpit seat frames were distorted but generally intact. The factory supplied tailored cushions were present and additional foam cushions contained within loosely fitting fabric 'pillowcase' covers were also present.

The passenger (right) seat had been unoccupied and was at its fully forward setting. The pilot's seat (left) was fully rearwards with its adjustment rail bent downwards through an angle of approximately 90º. Figures 1 and 2 show the seats and adjustment rail as found at the accident site (shown with all the cushions removed).

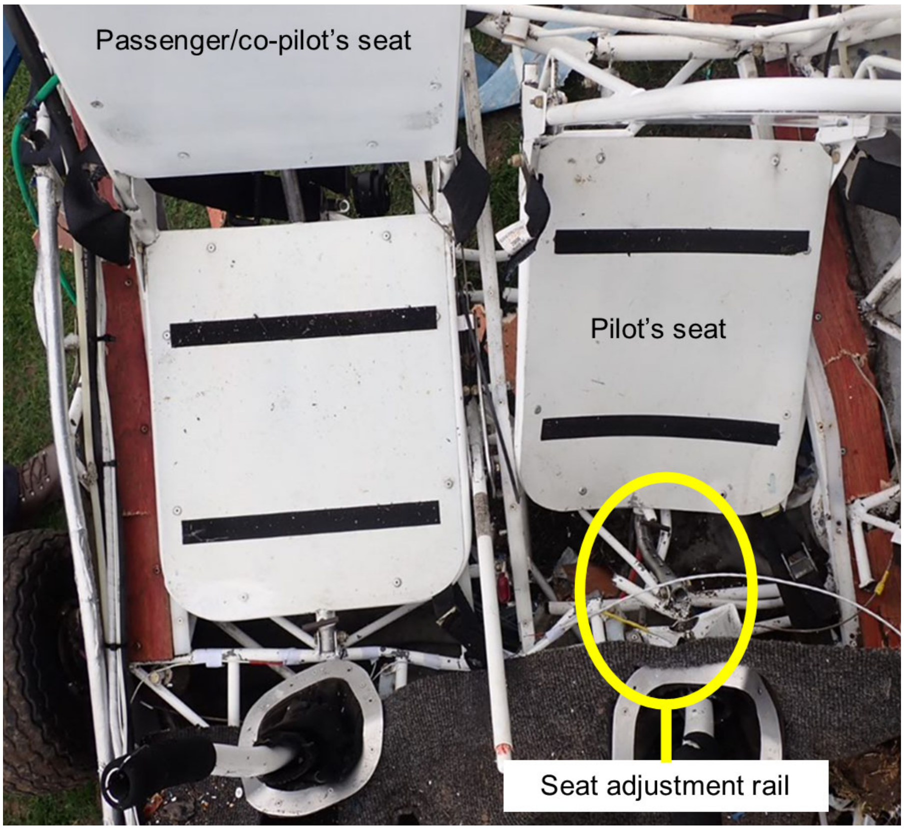

Figure 1

Seat as found at the accident site (cushions removed)

Figure 2

Damage to the pilot's seat adjustment rail

Recorded information

The aircraft was fitted with a PilotAware Rosetta unit. This broadcasts aircraft position and receives positional information of other aircraft to aid with avoiding other traffic. This is supported by a network of ground stations. The unit has a GNSS module and records the track information to a microSD card. It gathers data for short periods before recording it on the memory card; anything not written to the card when power is lost is not recorded. The last update to memory was just after the aircraft lined up on the runway for takeoff. However, one of the ground stations was on the airfield. A track relating to the climb and initial descent was recorded by the network and provided to the AAIB for analysis.

Previous flights were recorded within the unit. There was only a small sample of flights associated with takeoffs from Breighton logged against the pilot/accident aircraft pairing, and different takeoff profiles were flown including training, so there was no clear picture of 'normal' for the pilot/aircraft pairing.

After a previous accident at the airfield, the CCTV coverage was changed to better cover the runway activity. As a result of this forethought, parts of the accident flight were recorded by three CCTV cameras installed in various locations at the airfield, affording greater understanding of the events. The CCTV recordings were processed using photogrammetry software. The aircraft location and speed were already recorded so the focus of the photogrammetry was the changing aircraft attitude. The calculated orientation data is not considered highly accurate in this particular case.

A camera mounted to another aircraft captured the windsock at the takeoff end of the runway before and after the accident flight takeoff. This indicated a moderate headwind with a cross wind component from the left of the active runway, corroborating the meteorology information.

Accident flight

The takeoff roll of the accident flight started at 1203 hrs. Reviewing the audio recording of the initial part of the takeoff taken from the camera mounted on the other aircraft indicates that the engine was running at about 5,750 rpm. Taking into account the expected reduction in frequency of the audio due to the aircraft accelerating away from the recording location, the audio indicated a reduction in engine speed of about 5% during the early stages of the takeoff roll. The audio from the accident aircraft got quieter as it moved away from the recording device. It was no longer discernible from the noise of the aircraft on which the camera was mounted as the accident aircraft started to climb.

The recorded flight path of the accident flight is shown in Figure 3. The acceleration to takeoff was comparable with other recorded flights associated with this aircraft at the same airfield (some on the opposite runway). One of the CCTV cameras captured the takeoff roll and initial climb but there was insufficient contrast to calculate the aircraft orientation until the aircraft had climbed above the tree line in the background, at roughly 20 ft agl. As soon as it was visible, it was apparent that there was left roll and a left drift with the aircraft tracking to the right of the runway (Figure 4).

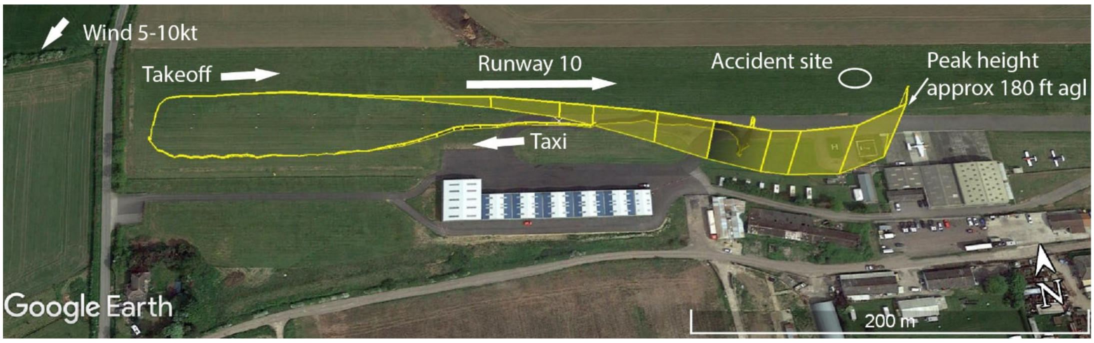

Figure 3

Track of G-CGNV using PilotAware ATOM GRID Network data
(Satellite imagery courtesy of Google Earth)

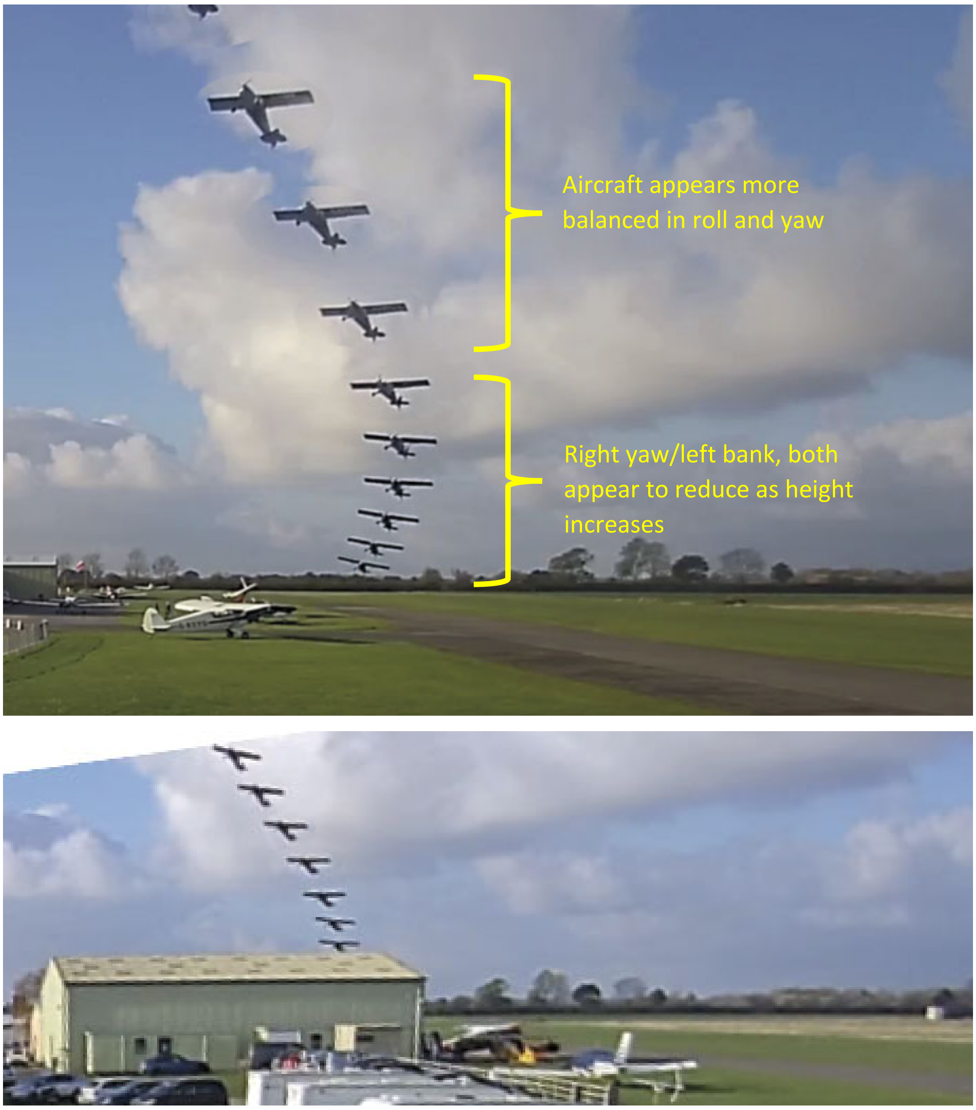

Figure 4

Cropped and combined snapshots of one of the CCTV recordings to show the aircraft flight path and orientation during a large part of the climb

The flight path data and the approximate orientation of the aircraft for the accident flight are shown in Figure 5.

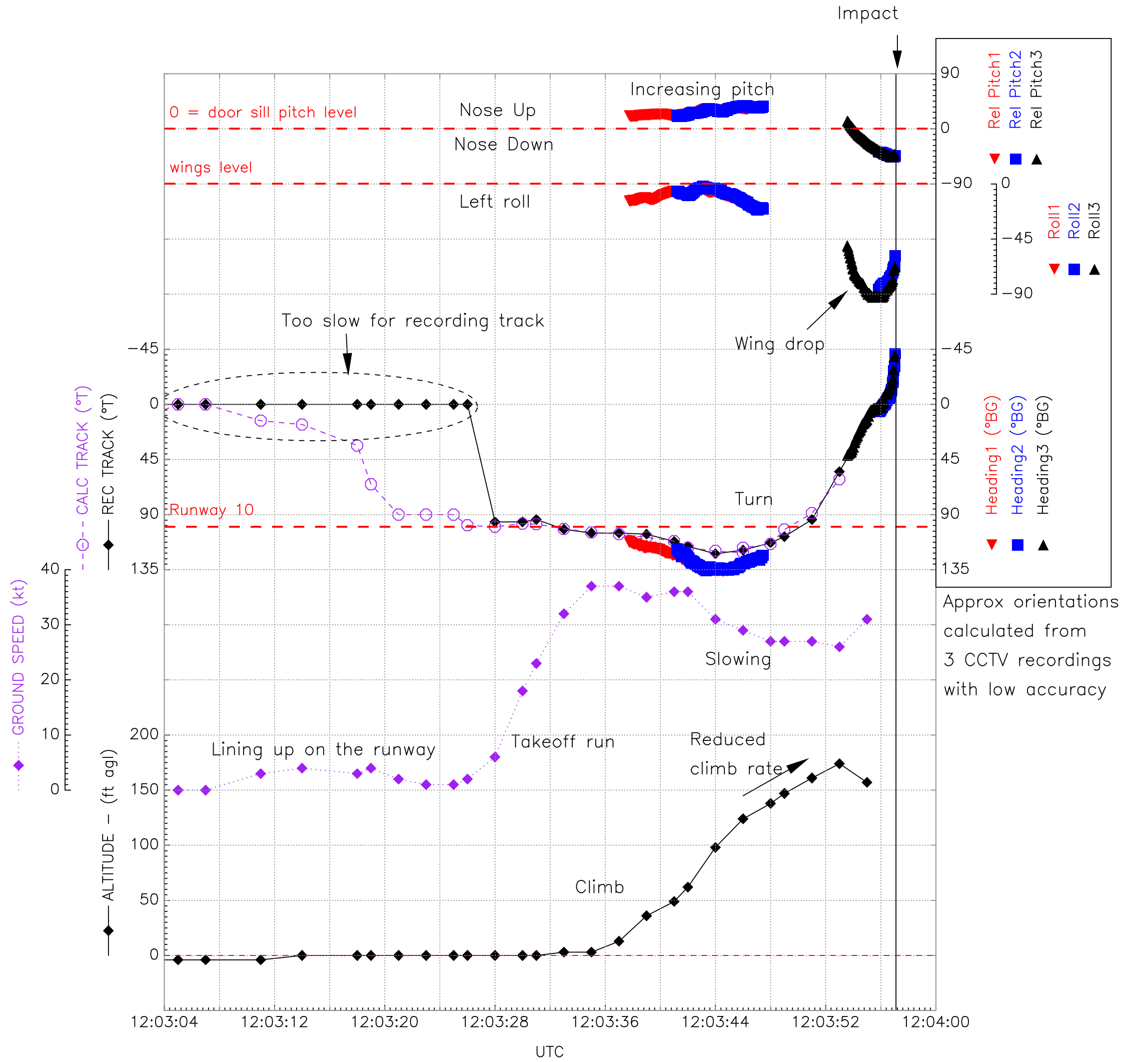

Figure 5

Data recorded by the Pilot Aware network and approximate orientation data derived from the CCTV recordings

The climb rate briefly reduced at about 40 ft agl but increased again at about 50 ft agl. Approaching 100 ft agl, the left roll had reduced to approaching wings level, but it started increasing again in conjunction with a turn to the left, a reduction in ground speed, and a reduction in climb rate.

The approximated aircraft pitch appears to have slowly increased throughout the climb while in the frame of a CCTV during the climb. CCTV coverage was lost climbing through about 130 ft agl. The data shows that the ground speed had reduced to about 27 kt at this point. This had reduced slightly on reaching the peak height of approximately 180 ft agl. The recorded data only recorded one further data point, showing a reduction in altitude. The aircraft appeared in the top of the frame of one of the CCTV cameras at the approximate apex of the flight. This recorded the left wing dropping to point straight down and the nose dropping as the aircraft descended. The aircraft started to roll the left wing back up but struck the ground with about 60° of left roll with a pitch attitude of about 45° nose down. The aircraft rapidly came to a halt indicating very high levels of deceleration.

The CCTV recorded a dispersal of fluid as the aircraft struck the ground, followed immediately by a post-impact fire that was extinguished by people on the airfield within one minute of the accident.

Aircraft information

The Escapade is a homebuilt, single-engine, high wing, monoplane fitted with tailwheel landing gear. The fuselage and empennage are a tubular steel space frame construction covered in fabric. An image of G-CGNV is shown in Figure 6.

The wings have tubular aluminium front and rear spars with wooden ribs which are also covered with fabric. The Rotax engine drove a three bladed fixed pitch propeller rotating clockwise when viewed from the cockpit. The engine cowling and twin fuel tanks, mounted within the inboard section of each wing, were constructed from fibreglass composite. It has dual controls operating the conventional primary flying control surfaces and cable operated flaps operated by a single lever. This aircraft was fitted with an elevator trim tab hinged on the left elevator which was set using a small lever between the seats.

Figure 6

Image of G-CGNV
(image used with permission)

Seat assembly and construction

The aircraft is fitted with side-by-side pilot and co-pilot seats. The seats are also of tubular steel construction with tailored foam fabric-covered cushions. The seat base cushions on G-CGNV were held in place on the seat pan by hook and loop Velcro strips. The seat back cushions were attached to the seat backs by a pocket in the seat coverings which were slid over the seat frame. Both seats slide backwards and forwards on flat plastic runner strips rivetted to box section tubes in the cockpit floor framework on which the outer frame tubes of the seat pans rest.

The seats are held in the selected position by a small spring-loaded pin centrally positioned at the front of each seat pan. The pin locates in equally spaced holes in a tube called an 'adjuster rail' attached to the cockpit floor middle and rear cross frame. Figure 7 shows the seat adjustment pin. The adjuster rail is attached by bolts and stiff nuts to lugs welded to the cross frames. The adjuster rail passes through a tubular bracing bracket, midway along the rail, which is bolted to the fuselage framework beneath the seat.

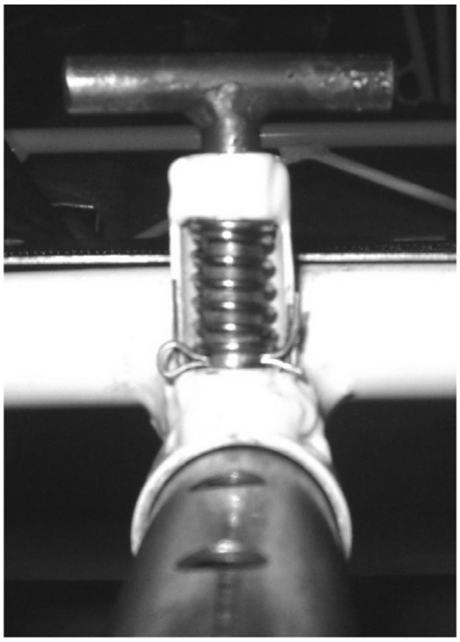

Figure 7

Image of seat pin from the aircraft assembly manual
(courtesy of the manufacturer)

The seats in this aircraft had 150 mm of travel from their fully forward position abutting the cockpit floor middle cross frame, to a stop collar on the adjuster rail. Both seats were fitted with a 25 mm wide webbing loop and cam buckle looped around the seat pan front tube and tubes which were part of the middle cross frame. These were designed to be tightened after seat adjustment. They were known as '*seat adjuster backup straps*' (Figure 8). The installation manual states that these are '*a safety backup in case of seat pin failure*.' The straps should be tightened to remove any slack before flight, after the seat position has been finally adjusted.

On G-CGNV, four-point safety harnesses were fitted for each of the seat occupants. The shoulder straps were attached to a cross bracing tube at the rear of the cockpit, and the lap straps were attached to the seat frame at the back of the seat pan. Therefore, if the occupant was correctly strapped in and the seat then moved rearwards, the two shoulder straps would slacken, however the lap strap would remain tight.

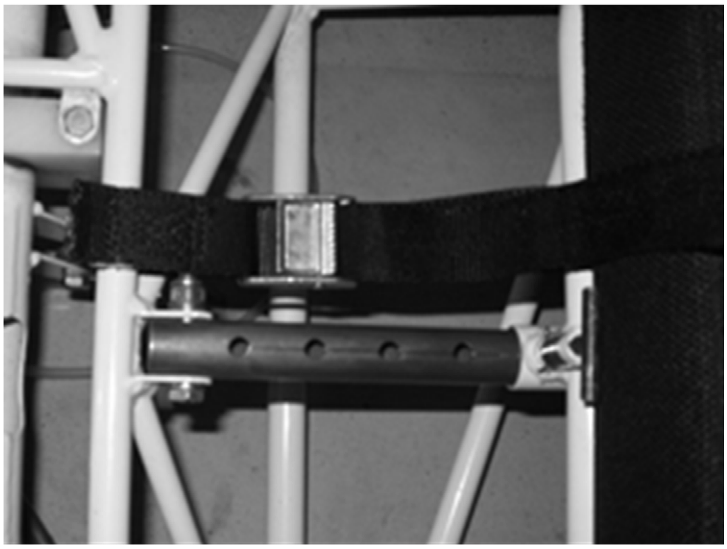

Figure 8

Image of the seat adjuster backup strap from the aircraft assembly manual
(courtesy of the current manufacturer)

Aircraft history

G-CGNV was originally built in 2008 and had two previous owners. It had a valid CAA Permit to Fly, issued on recommendation of the Light Aircraft Association (LAA). The current owners, two members of a syndicate, purchased the aircraft in August 2021. The aircraft had a period of non-flying prior to its purchase.

Recent maintenance history

During the aircraft survey in preparation for the revalidation of the Permit to Fly, numerous minor defects were found and rectified by the syndicate members. At the same time, they carried out an annual service during which documentary evidence shows that the seats were removed, and the adjustment mechanisms lubricated. A Certificate of Validity revalidating the Permit to Fly was issued in September 2021.

Aircraft construction

The aircraft was built from a kit. The welded tubular steel airframe is supplied complete but requires the fittings and components to be fitted by the owner in accordance with an illustrated construction manual. Chapter 6 of the manual describes how to fit the seats to the runners and how to assemble the adjuster rail and seat pin. The verbatim extract describing this in the manual is as follows.

> *'The seats slide up and down the seat adjuster rails to give seating position adjustment. The most forward position is reached when the seat is against the seat adjuster rail bracket. The most rearward position is reached when the seat hits the stop bushing installed at step 7.*

Intermediate adjustment points need to be drilled into the seat adjuster rail, use the seat locking pin guide. Position the seat at the most forward position and drill a hole (1/4")[1] through the top section of rail (don't go through both sides of tube), move the seat back in 1" increments and drill for these positions until the rear stop is reached (yes you do need to drill for the rearmost position – positive locking of seat). These holes can be reamed and cleaned out as necessary to ensure that the locking pin moves into and out of the holes without sticking.'

In G-CGNV seven holes had been drilled to give a 150 mm range of seat movement.

Previous incident

In 2015 a minor accident involving G-CGNV was reported, and a report was subsequently published[2]. The aircraft had been taxiing at a fast walking pace when the right landing gear strut collapsed, and the right wing tip and propeller struck the ground.

Aircraft examination

General

The aircraft was recovered to the AAIB hangar for further examination. Apart from the removal of both wings, the fuselage structure had broken into three main parts. The engine bay and firewall structure had separated from the cockpit floor section. Both sections were severely disrupted commensurate with the aircraft hitting the ground. The tail section and empennage structure of the aircraft had parted from the cockpit floor only being held by control cabling and rods. However, in general it was less damaged and had retained its basic shape.

The left tailplane tip was damaged during the accident. A small compression spring[3] that should have been fitted around the piano wire between the conduit bracket, which was attached to the underside of the left tailplane, and the tab horn was not present. In the cockpit, the elevator piano wire had pulled out of its clamp nipple on the trim lever. As a result, the exact setting of the cockpit trim lever or trim tab could not be determined.

The flap lever was set at the first stage of flap, but due the damage to the wings and cockpit distortion the exact flap position prior to the accident could not be positively determined.

The rudder was intact and had a full range of movement. The rudder pedals were correctly attached to the cockpit front floor frame. There was continuity between the rudder cables,

Footnote

[1] The ¼ inch hole equates to 6.35 mm.

[2] AAIB investigation to Escapade, G-CGNV - GOV.UK (https://www.gov.uk/aaib-reports/aaib-special-bulletin-s3-slash-2021-on-escapade-g-cgnv) [Accessed September 2022]

[3] The conduit from which the piano wire emerges, is clamped to a small bracket on the underside of the tailplane. The piano wire is attached to a horn on the trim tab and as the wire is moved by inputs from the trim lever in the cockpit the tab moves up or down. Under some flight conditions there can be the onset of trim tab flutter, to prevent this, a small spring is fitted which surrounds the piano wire and reacts against the bracket and tab horn.

which ran in conduits either side of the fuselage, and the rudder. There were two turnbuckle adjusters between each cable and the pedals. These were found to have been adjusted to their shortest setting. They were correctly wire locked and undamaged. Documentary evidence showed this adjustment had recently been done by the accident pilot to bring the rudder pedals as far rearwards as possible to bring them nearer to the pilot's and passenger's seats.

The battery had detached itself during the accident and was found lying on the ground near the aircraft. Prior to the accident the battery was mounted on a wooden plate fitted to the airframe in the tail section approximately 620 mm forward of the tail wheel. The battery was held in place by a 50 mm-high wooden framework surrounding the lower portion of the battery. This framework had parted from its wooden plate, along with its hook and loop strap which was attached to it. This assembly was not substantial enough to hold the battery in place under the high loads encountered during the accident.

The engine crankcase and cylinder assemblies were relatively undamaged, but the majority of ancillary equipment had detached or become severely distorted during the accident. There was also evidence of light fire damage on some of the components.

Both wings and associated flying controls were distorted with extensive fire damage. Approximately 95% of the fabric skin covering had burnt away.

Cockpit and seats

A detailed examination of the both the seats, harness and adjustment mechanisms was carried out.

The passenger (right) seat was at its fully forward position although the seat pin was not fully located in the adjuster rail hole. The box section seat runners and seat frame were distorted and misaligned and there was a slight bend in the adjuster rail which prevented movement of the seat; these were consistent with the forces during accident. Although the pin was stiff in its guide collar attached to the front of the seat pan structure, it could be moved by hand.

The pilot's seat (Figures 1 and 2 earlier) had been forced downwards between its runners and there was a severe bend in the seat adjuster rail. There was a distinctive score mark running along the upper face of the adjuster rail tube which was offset with the centre line of the pin location holes. There was also evidence of burrs similarly offset on the edges of the holes. Figure 9 shows the score mark and burrs. This mark and the hole burrs extend from the forwardmost hole in the adjuster rail to the fourth hole. The severe bend in the tube had distorted the remaining holes further back, to the extent that holes five and six were 'closed-up' and hole seven was hidden within the seat guide tube which ran along the rail.

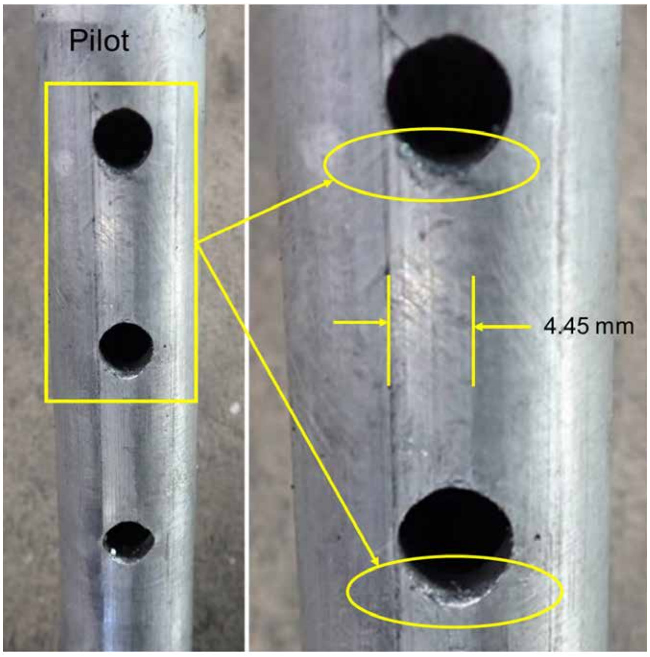

Figure 9
Score mark and burrs on the hole edges on the pilot's seat adjuster rail

For comparison the passenger seat adjuster rail mark is shown in Figure 10.

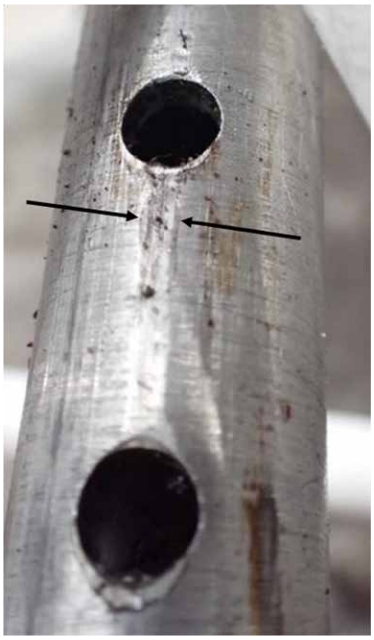

Figure 10
Passenger seat adjuster rail marks (highlighted)

The witness mark in the passenger seat adjuster rail, although feint, tracked the centre line of the holes. There was also some burr damage on the edges of the holes but without any significant offset.

Pilot's seat adjuster rail measurements

The aluminium alloy seat adjuster rail tube was 19.0 mm in diameter with a tube wall thickness of 3.3 mm. Where possible, measurements were taken of the visible holes which were found to have a diameter variation between 6.37 and 6.41 mm. The mark on the tube was 4.45 mm wide and offset against the hole centre line to the left by 0.43 mm. The pin was damaged and slightly bent but its engagement end could be accurately measured. The pin diameter was 6.30 mm and was chamfered leaving an end face diameter of 4.45 mm. The pin end is shown in Figure 11 and a schematic cross-sectional diagram of the dimensions and offset are shown in Figure 12. The offset shown in the diagram, represents the pin as it would naturally sit based on the dimensional evidence. The tolerance within the pin guide, plus any wear, allows the pin to advance further downwards such that the chamfer just engages in any of the adjuster rail holes against their edges. The evidence for this is shown in the preceding Figure 9.

Figure 11
Pilot's seat pin chamfered end

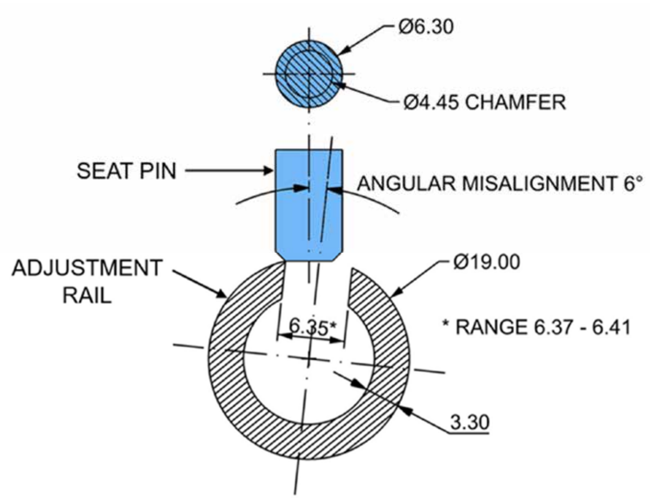

Figure 12
Schematic cross-sectional diagram of the adjuster rail dimensions and pin offset (not to scale)

The forward attachment fitted to the cross frame had distorted and the left lug had broken away from the frame. The attachment bolt and nut were still in place but were not particularly tight. Figure 13 shows the pilot's seat adjuster rail front mounting assembly. The rear mounting point was in a similar condition to the front.

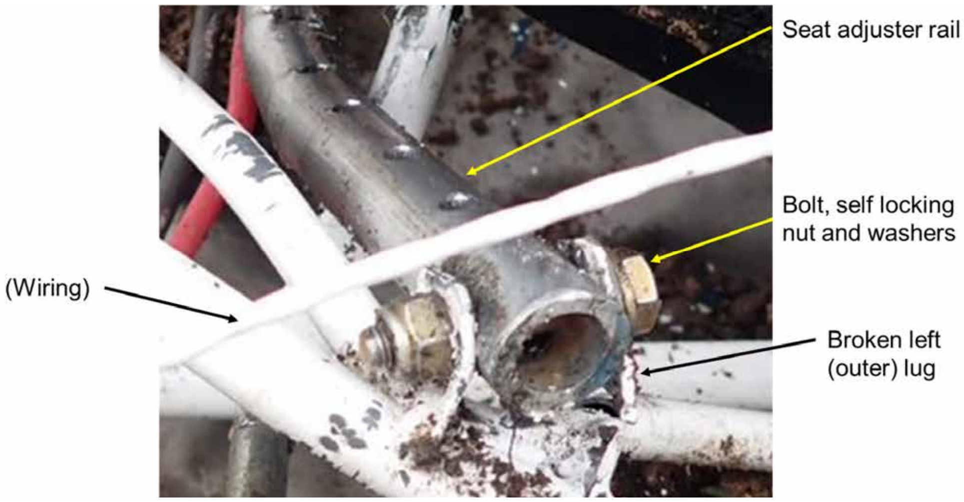

Figure 13

Pilot's seat adjuster rail front mounting assembly

The front and rear lug holes were 6.49 mm diameter, the bolts were 6.2 mm diameter. The adjuster rail front mounting holes were 6.48 mm diameter. However, the rear mounting hole on the left side of the adjuster rail was slightly larger at 7.0 mm diameter. These measurements were standard clearance holes and when the bolt was loosened, allowed a play of between 0.28 mm and 0.29 mm, except in the case of the rear 7.0 mm hole, where the play was 0.8 mm. The mounting bolts on both adjuster rails showed evidence of wear, movement and fretting. The pilot's adjuster rail bolts appeared to be more worn than the passenger adjuster rail bolts (Figure 14).

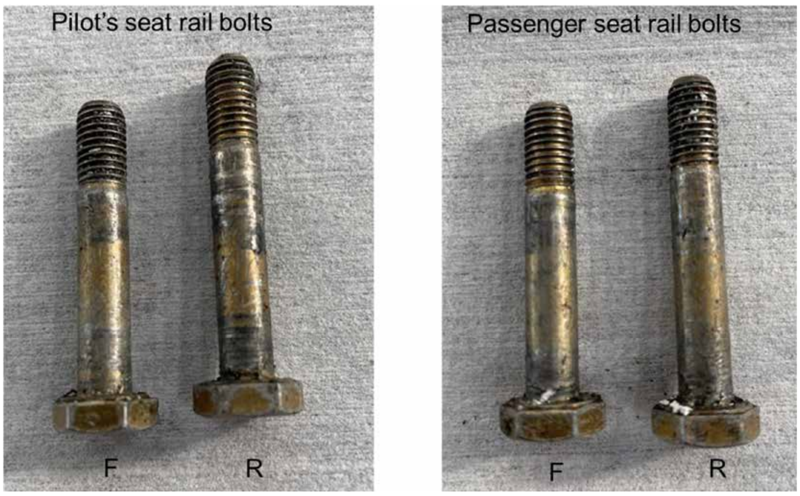

Figure 14

Pilot's and passenger seat adjuster rail mounting bolts

Backup straps

The passenger seat backup strap was loose around the front seat pan tube and the upper and lower tubes within the cockpit middle section frame. Its cam buckle operated correctly.

The pilot's seat backup strap was fitted in the same way as the passenger seat backup strap. Its cam buckle was over rotated and jammed because the webbing strap had been placed under significant tension[4] (Figure 15).

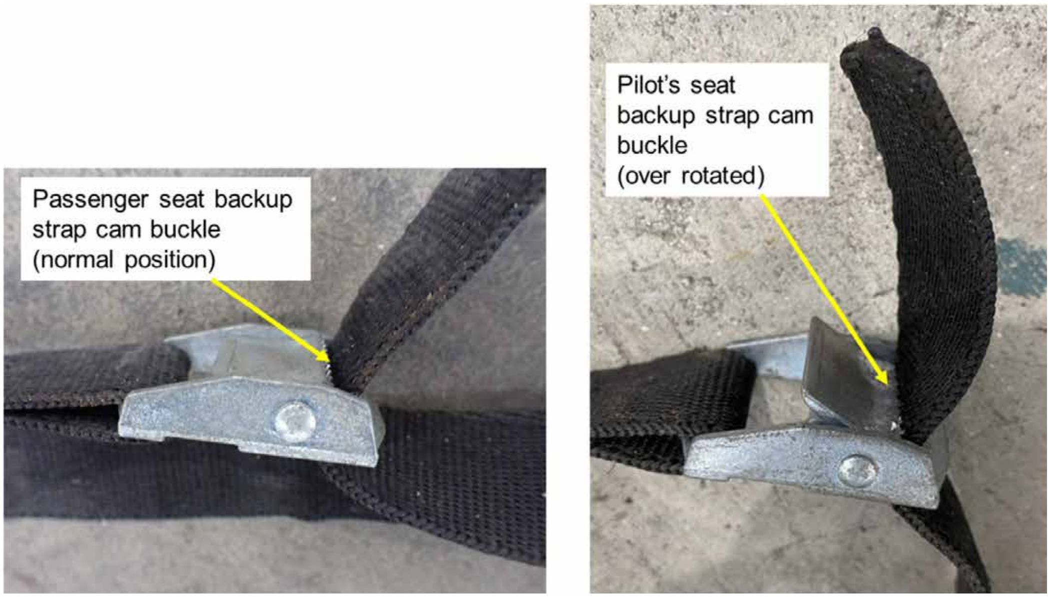

Figure 15

Backup strap buckle condition

Seat modifications

In G-CGNV, additional foam pads had recently been made and fitted to both seats to raise and move the pilot and any passengers higher and forward on the seat. They consisted of roughly square pieces of expanded foam padding. The seat pan pads were 380 mm wide and 440 mm long and 20 mm thick. The seat back padding consisted of a piece of foam folded into three layers. This formed a cushion which was 320 mm wide and 480 mm long and 75 mm deep. The pads were enclosed within a loose-fitting black fabric standard size pillowcase. The extra cushions were approximately the same dimension as the factory-made cushions which were formed and shaped for the purpose with a tight-fitting woven fabric covering.

Footnote

4 The buckle mechanism in the backup strap uses the serrated face of a spring-loaded cam on top of the webbing which passes between it and flat plate in the buckle. The webbing is easily pulled past the cam in its 'opening' direction. When pulled in the other direction, it causes the cam to rotate and its geometry then results in closing of the gap between the cam and flat plate trapping the webbing in between. The greater the force in this direction the further the cam rotates, gripping the webbing tighter. To release the webbing the cam can be 'opened' by its lever.

The seat pan foam padding was loosely placed under the factory-made cushion but was not fitted with the hook and loop strips positioned to attach the factory cushion to the seat pan. The seat back padding was fitted on the face of the factory-made seat back and the whole thing enclosed in a pillowcase and then slid over the seat back. Figure 16 shows the seat frame fitted with the padding and factory-made cushions.

Figure 16

Seat cushion and padding modifications

Survivability

The aircraft sustained high g forces at impact such that the injuries sustained by the pilot were not survivable.

Weight and balance

Based on the evidence available to the investigation, at the time of the accident G-CGNV was within its placarded operating weight limits and approved CG envelope.

Aircraft piloting considerations

Directional stability

Testimony from pilots who had flown the Escapade type indicated that it did not have strong directional stability and usually required active rudder pedal input at all stages of flight. Changing engine speed further affected directional stability due to the rpm-dependent yawing moment generated by the propellor[5]. At high power settings, such as used during takeoff and climb, this destabilising moment would be significant. For G-CGNV, with its clockwise rotating propellor[6], the imparted yawing moment was to the left, requiring compensatory right rudder pedal input to keep the aircraft in directionally balanced flight.

Footnote

5 https://skybrary.aero/articles/p-factor (accessed 26 June 2022).

6 When viewed from the pilot's seat.

Pilot's operating handbook

In 2006, the BMAA published an '*Escapade Operators Manual*[7]' aimed at providing '*the information that a qualified pilot requires to fly* [the type] *safely.*' The manual's list of the minimum pre-flight inspection items included a '*check* [that the aircraft's] *seats and cushions are secure.*' The manual does not include a consolidated checklist for all flight phases but does recommend that Escapade pilots use the BMAA standard pre-takeoff checks[8].

For Escapade aircraft under LAA oversight, the relevant Type Acceptance Datasheet[9] states that the operator's manual issued by the BMAA is the applicable Flight Manual. It also stipulates that LAA Operating Limitations take precedence for LAA-monitored aircraft.

Meteorology

At the time of the accident the weather at Breighton was good. There was no significant low cloud or precipitation, the visibility was greater than 10 km and, as evidenced by captured images of the windsock at the airfield, the surface wind was north-easterly at 5-10 kt.

Personnel

The pilot gained his pilot's licence in 2008 and had flown over 950 hours on light aircraft. His licence and flying medical were valid for the intended flight.

The investigation heard that the pilot was a keen and conscientious flier who regularly delivered safety promotion briefings to members of his local flying association, of which he was chairman. He often acted as a coach and mentor to more inexperienced aviators as part of the LAA's Pilot Coaching Scheme.

The pilot's post-mortem did not find evidence of any medical factors that would have been contributory to the accident. The pathologist determined that the pilot had been 165 cm (5 ft 5 in) tall with a functional leg reach from buttock to heel of approximately 69 cm (27 in).

Given his stature, the pilot required the seat to be in its most forward position for him to obtain effective control authority over the rudder pedals.

Escapade aircraft seating assessment

Experiments were conducted using three other tail-wheeled Escapade aircraft to understand how the seat adjustment and backup strap system operates and to establish the cockpit ergonomics with a person of the same stature (Similar Person), in particular the same leg length, as the pilot sat in the aircraft.

Footnote

7 Escapade Operators Manual Issue 1 AL3, Oct 2006.
8 Following the mnemonic CHIFTWAP and listed in para 4.6 of the Escapade Operator's Manual.
9 LAA Type Acceptance Datasheet TADS 845 Sherwood Scout [formerly known as the Escapade].

Seat pin and adjuster rail operation

Two of the example aircraft had six holes drilled in their adjuster rails giving them a seat a range of movement of 125 mm. The third aircraft had the same range of seat movement as found in G-CGNV of 150 mm. All the seating in these aircraft was the factory standard tailored cushion without any modification. All three aircraft were fitted with backup straps, although the pair of straps found in one of the aircraft were in poor condition.

All the seat rails in these aircraft worked correctly, positively locking the seats into the chosen position. With the seat occupied and the pin lifted, the seats tended to slide to the rearmost position without having to be pushed.

To slide the seats forward both hands were required, one hand to lift the pin and the other to grip and pull on the framework near to the windscreen. In both cases, forwards or backwards, the seat slid along its runners with ease. It was easy to lift the pin and slide the seat to the desired position in one coordinated movement.

When the pin was released midway between the adjuster rail holes and the seat slid slowly backwards or forwards, the pin would snap into the next hole with a 'click' under its spring pressure. Despite an audible indication of the spring location, it was not particularly easy to visually determine its position from the seat occupant's viewpoint. The height difference between the pin being in a hole and not being in a hole but resting on the rail, was approximately 5 mm making it difficult to ascertain the difference when viewed from above when sitting in the seat.

However, when the pin was lifted and positioned between holes and the seat moved back or forward quickly, the pin tended to 'skip' across the holes and not engage as it went past.

Seat position ergonomics

In the aircraft with 150 mm of seat travel and with the seat set fully rearwards, the distance from the rudder pedals in the neutral, rudder-centred, position to the forward edge of the seat pan frame was 80 cm.

A set of experiments were carried out in various seat positions with the Similar Person strapped in to the four-point harness. It was noted that all these aircraft rudder pedal positioning turnbuckles were set to their mid-range. The rudder pedals in G-CGNV had been set at their most rearwards position.

When the seats of all the example aircraft were fully forward the Similar Person could reach all the flying controls and the throttle, and was able to operate them throughout their full range of movement with ease.

With the seat in the 125 mm range aircraft fully rearwards, the pitch and roll control using the stick was still possible throughout its full range but required a little extra stretch reach and shoulder movement to push the stick fully forward. The throttle full power, fully in, position required the same. However, the rudder pedals were more difficult to operate and required additional stretch to operate them.

The same experiments were repeated in the 150 mm seat range aircraft. With the seat fully forward the same results were achieved. However, when the seats were fully rearwards, it was found more difficult, but still possible, to achieve the full range of pitch and roll control and to comfortably operate the throttle. However, the rudder pedals could not be reached at all by the Similar Person with the seat in its most rearwards position with or without the use of additional cushions and padding as found in G-CGNV.

With the seat in this position and the shoulder straps slackened this allowed 160 mm of forwards movement of the upper torso. Operation of the control column and throttle was still possible. The lap strap did not slacken at all because it is fitted directly to the seat pan and therefore did not allow any lower body movement. As before the rudder pedals could not be operated with the seat in this rearmost position.

The action required to slacken the lap or shoulder straps required two hands to lift the adjustment buckle on each strap and to pull the webbing loop outwards. The safety harness could be completely undone using one hand to twist the release lever on the centre buckle.

Seat position for cockpit access

Witness evidence suggests that the pilot and co-owner of his aircraft were in the habit of sliding the seat fully rearwards when exiting the aircraft. This action was to enable easier entry into the cockpit and to avoid snagging their legs on the control column and instrument panel. For the seats to be slid fully rearwards the seat adjustment backup straps would need to be slack. While it is understood that the pilot knew the purpose of the backup straps, they found them awkward to use and, therefore, tended not to tighten them after adjusting their seat position.

Discussions with other Escapade owners and experiments in entry and exit from example cockpits with people of varying sizes showed little difficulty in entering and exiting the cockpit from either side with the seats in any position.

AAIB observations

Battery box

The battery had become dislodged from its mounting within the rear fuselage when the aircraft struck the ground. Examination found the wooden battery surround and hookandloop strap had detached from the wooden base plate. The movement of the battery had caused the positive and negative terminals to fracture, disconnecting the battery. The battery was free to travel through the rear fuselage and exit in the vicinity of the damaged passenger seat area of the cockpit.

This wooden battery box may not have been the original design or in its original location. The method of holding the battery in place using the hook-and-loop strap attached to the battery surround relied on the glued joint between it and the base to hold the battery in place.

Useful guidance on battery fitting and restraint is contained in a leaflet[10] published by the British Gliding Association (BGA). This guidance is considered to equally apply to powered light aircraft.

Elevator trim tab spring

Examination of the flying controls identified a component missing from the elevator trim tab actuator cable. There should have been a small compression spring surround the trim tab piano wire cable between the cable mounting plate where it exits the underside of the tailplane and the actuation horn mounted on the tab. The purpose of the spring is to prevent a tendency for a small amount of trim tab flutter to develop under certain conditions. The absence of the spring has no bearing on this accident but shows how easily a minor deviation from the design can be overlooked.

Analysis

Examination of the aircraft structure, its flying control system and power plant found no evidence of failure or malfunction, except for the pilot's seat adjustment mechanism, that could have led to this accident. While implicit, there was no specific direction in the Escapade Operator's Manual to check the seat adjustment pin was correctly located and the secondary securing strap tensioned. Based on the evidence available to the investigation, at the time of the accident G-CGNV was within its placarded operating weight limits and approved CG envelope.

Loss of control

The pilot was able to taxi successfully and line the aircraft up on the runway, indicating that he could exercise effective control over the rudder pedals until at least the start of the takeoff roll. It would be reasonable to expect that if the seat problem had developed on the ground the pilot would have rejected the takeoff. CCTV evidence showed that by the time it passed approximately 20 ft agl, G-CGNV already had significant left bank and was yawing to the right, generating left drift. Despite the left drift, the north-easterly wind resulted in the aircraft tracking to the right (south) of the runway. The abnormal initial climb attitude and the radio call from the pilot reporting a problem with his seat, indicated that the pilot did not have full control of the aircraft by that time.

Testimony from pilots who had flown the Escapade type indicated that the right yaw after liftoff was at odds with the natural tendency of a Rotax-equipped Escapade to yaw left if power was applied without compensatory right rudder input. The investigation did not find evidence to determine how the initial right yaw developed but considered it could have resulted from yaw inertia generated by the pilot correcting a left yaw divergence prior to, or at the moment of, seat movement. If caused by a lateral stick input, the left roll would have induced an adverse aileron yawing moment, exacerbating any right yaw divergence and requiring rudder input to counter it. The investigation did not find evidence that yaw divergence of the scale seen on the accident flight was a common problem for the aircraft

Footnote

[10] BGA Airworthiness and Maintenance Procedures (gliding.co.uk) accessed 23 June 2022.

type and concluded that it is highly unlikely the divergence would have occurred if the seat had not moved rearwards.

It was not possible to conclusively determine how the aircraft came to adopt the observed unusual climb attitude or why the pilot was then unable to avoid the departure from controlled flight. The investigation considered the most likely reason to be one, or a combination of, the following factors:

- Intentional control inputs by the pilot while attempting to establish a climbing trajectory but without sufficient control authority to generate a safe outcome.
- Intentional control inputs by the pilot while attempting to fly back towards the runway for an immediate landing but without sufficient control authority to achieve the aim.
- Unintentional control inputs generated when the pilot slid backwards while still holding the stick.
- The aircraft diverging from a normal climb attitude because it was not under continuous positive and direct control, either due to the pilot's compromised seating position or because he necessarily released the stick while attempting to reposition the seat.

Had the pilot been able to establish a continuous climbing trajectory, he might have been able to reach a safe height at which to attempt a repositioning of the seat with both hands off the controls.

Passenger seat position

The passenger seat was fully forward with its pin in the first hole in the adjuster rail but it was not fully located in the adjuster rail hole. It is possible the shock loading of the cockpit framework and distortion of the adjuster rail in the accident may have caused the pin and adjuster rail to interact lifting the pin slightly. The pin was stiff to move in its guide collar which might explain why the pin had not moved back down into the adjuster rail hole under its own spring force.

Pilot's seat movement

If the seat pin had been correctly located in the adjuster rail, the seat would have remained in its selected position. The examination and measurements of the seat adjuster rail and seat pin show that they were incorrectly aligned which hindered positive engagement of the pin in the location holes. Marks on the rail and the offset location of burrs made by the pin on the edge of the holes also suggest that the misalignment has been present for some time. This is supported by witness testimony that indicated difficulties had been experienced by the pilot in positively setting the seat position. It is therefore likely that on some occasions when the seat had felt secure, it was being held in place only by the edge of the chamfered end of the pin partially entering the hole as shown in the schematic in Figure 17.

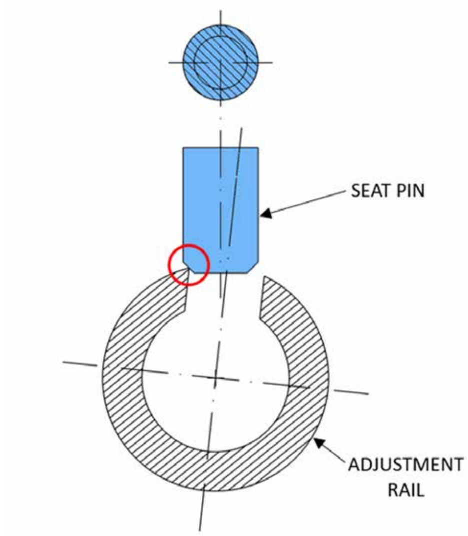

Figure 17

Illustration of partial seat pin engagement (not to scale)

The experiments conducted by the AAIB show that when occupying the seat, it is not easy to see that the pin has fully engaged in its hole. However, the seat pin audibly clicks into place as the pin drops into the hole. In this case the misalignment of the adjuster rail and pin in G-CGNV would not have given that audible reassurance.

The angle that tail-wheeled Escapade aircraft naturally sit allows the seat to move freely and easily rearwards if the pin is not correctly engaged. It is likely the combination of the acceleration during the takeoff roll and the increased pitch at and after rotation, with the pin in an unsafe condition, meant the seat suddenly moved rearwards.

Interaction of the additional seat pan padding and loose pillowcase material with the pin was considered. It is plausible that the pilot's weight and movement on the seat pan caused the padding to squash outwards, act on the pin enough to dislodge its chamfer edge from where it was resting against the adjuster rail hole. Therefore, interaction between the additional seat pan padding and the pin in its sensitive position could not be ruled out.

Adjuster rail misalignment

The damage to the aircraft prevented accurate seat and airframe alignment checks. During disassembly the stiff nuts holding the bolts in place were found not to be particularly tight. Examination of the bolts found wear marks on their surface plating on areas of the bolts in direct contact with the rail and its mounting lugs. Similar bolts removed from other parts of the structure through tubing and lugs, did not exhibit the same wear marks. This suggests there had been some movement or fretting over time between the adjuster rail and its bolts.

The method of assembly detailed in the construction manual makes it difficult to drill the holes in the adjuster rails for the pin in the incorrect places. It is probable that it had worked in a similar way to that demonstrated during AAIB examination of the three example aircraft.

There is documentary evidence that this aircraft had a right landing gear collapse in 2015. The aircraft was repaired and there is no mention in its history file that any damage was caused to the seat framework or adjuster rails. After the repair, the previous owner continued to the fly the aircraft without any problems. He described how he rarely needed to move the seat, usually only for maintenance, so did not notice any difficulties with either of the seats.

There is also documentary evidence that the pilot's and passenger's seats were recently removed to lubricate the adjuster rail during annual maintenance. This would have been a relatively simple task which involves the loosening and removal of the adjuster rail attachment nuts and bolts from the attachment lugs, and the bracing bracket bolts from the framework. When the adjuster rail was refitted the orientation of the attachment lugs and the tolerance between the bolts and lug holes would have dictated the angular position of the adjuster rail. The bracing bracket had no effect on the angular position of the adjuster rail.

The magnitude of misalignment in this case would not be immediately obvious to an individual refitting the assembly. They would naturally assume the simplicity of the fittings would mean they would go back together as before. It is possible that during reassembly the tolerances of the fitting might have allowed a small misalignment to be introduced. However, the pronounced score marks suggest the misalignment may have been present prior to the most recent disassembly, but this may not have been immediately obvious.

It was not possible to explain exactly when or how the misalignment in the pilot's seat adjuster rail came about. However, an undetected consequence of the landing gear collapse on the cockpit and seat geometry, or further misalignment during reassembly, could not be discounted.

Ergonomics

The evidence shows that the pilot's seat was at its rearmost position prior to the aircraft striking the ground. The stature of the pilot was such that with the seat in this position, he was likely to have been able to reach and exercise pitch, roll and throttle control but he was not able to make any effective use of the rudder pedals. Faced with this situation the temptation might have been to attempt to reposition the seat to the fully forward position needed by the pilot. To do this, as shown during experimentation, he would have needed the use his left hand to grip and pull on the framework near to the windscreen and his right hand to lift the seat pin.

The fact that the seat pin malfunction allowed the seat to move rearwards would probably not have been considered and understood by the pilot in the situation he was immediately faced with. Therefore, it is possible that he would have automatically tried to lift the pin to move the seat in any attempt to reposition the seat.

If he attempted to reposition the seat the pilot would have been forced to remove his hands from the controls. In addition, his movement would not have been made any easier by the safety harness. It would not have allowed any movement of his pelvis forward and only allowed a small, perhaps 160 mm, of forward movement of the upper torso.

Backup straps

The backup strap fitted to the pilot seat was found slack and almost at its full extension. It was therefore ineffective in preventing the seat moving rearwards. The build manual of the aircraft clearly states their purpose and how they should be used, but this is not stated in any pilot's operating handbook for the type. It is understood that the pilot and co-owner of this aircraft knew the purpose of the backup straps but found them awkward to use.

The pilot's backup strap had been subjected to a high tensile load during the accident which had caused the buckle to jam. This was caused by the downwards bend to the adjuster rail and it caused the backup strap to create additional distortion of the cockpit frame which it was looped around. The backup strap was pulled downwards very sharply, which caused the buckle cam to over centre and jam.

Conclusion

The pilot was correctly licensed and qualified to undertake the intended flight and there was no evidence of medical factors contributing to the pilot losing control of the aircraft.

The investigation concluded that the accident resulted from the pilot's seat sliding backwards when, or very shortly after, the aircraft lifted off. The rearward movement of the seat compromised his ability to maintain, and/or regain, effective control of the aircraft in the time and height available to him. The evidence strongly indicates that the seat adjustment pin was not correctly located in one of the holes in the adjustment rail.

The pin was not correctly located in the adjustment rail hole due to a misalignment between the centre line of the pin and the centre line of the adjuster rail holes. It was not possible to determine the exact cause of the misalignment of the seat pin and adjuster rail.

Safety actions/Recommendations

An uncommanded seat movement appears to have caused the pilot to lose full and effective control of the aircraft, with catastrophic consequences. The evidence showed that the pilot's seat pin was not correctly located in one of the holes in the adjustment rail and therefore the seat was not locked in place. The investigation found that it is difficult to confirm correct pin location while occupying a seat and, for forward positions of the seat, it might not be possible to vacate the seat to check the pin location. Additionally, the seat adjuster backup strap, designed to prevent rearwards seat movement in case of pin failure, had not been tightened before flight.

On the UK register there are 36 Escapade aircraft, and 7 Sherwood Scout aircraft of similar design. These operate on Permits to Fly administered by the BMAA and LAA. Given the possibility for a seat to not be properly locked in place and the secondary locking to not be secure, the AAIB made Safety Recommendations in Special Bulletin S3/2021 on 14 December 2021:

Safety Recommendation 2021-049

It is recommended that the Light Aircraft Association remind owners of this aircraft type of the necessity, after every seat position adjustment, to:

- ensure that the seat pin is correctly locking the seat in position, and
- set the seat adjuster backup strap after the desired seat position has been selected.

The Light Aircraft Association accepted this Safety Recommendation with the following response:

'The LAA wrote to the owners of all Reality Escapade and Sherwood Scout aircraft on the LAA fleet in December 2021 advising them of AAIB Bulletin S3/2021, and advising: "... please ensure that after every seat position adjustment and prior to takeoff, that the seat locking pin is correctly locking the seat in position and that the seat adjuster backup strap has been set after the desired seat position has been selected.". The LAA Reality Escapade / Sherwood Scout Type Acceptance Data Sheet (TADS) was also revised to add a Special Inspection Point regarding the seat adjustment and referring to AAIB Bulletin S3/2021.'

And subsequent to this initial action:

'In February 2022 the LAA issued LAA Technical Service Bulletin TSB-01-2022 to promulgate The Light Aircraft Company (TLAC) SB 01-2021 and CAA MPD 2022-004E. The LAA wrote to the owners of all Reality Escapade and Sherwood Scout aircraft on the LAA fleet advising them of these documents, and the LAA Reality Escapade / Sherwood Scout TADS has been up-issued to reference these documents.

February 2022's Light Aviation magazine contained an article based on AAIB Bulletin S3/2021 and highlighting the risks associated with adjustable seats. Also in February 2022, the LAA issued LAA Alert A-003-2022 to promulgate CAA SN-2022-001.'

The AAIB has categorised the response to this Safety Recommendation as 'Adequate – closed'.

Safety Recommendation 2021-050

It is recommended that the British Microlight Aircraft Association remind owners of this aircraft type of the necessity, after every seat position adjustment, to:

- ensure that the seat pin is correctly locking the seat in position, and
- set the seat adjuster backup strap after the desired seat position has been selected.

The BMAA accepted the Safety Recommendation listed above and has carried out the following actions in response.

‘1. Copies of AAIB’s Special Bulletin S3/2021 on Escapade, G-CGNV were sent via e-mail to all BMAA Inspectors and owners of Escapade and Sherwood Scout aircraft under the airworthiness approval of the BMAA on 14th December 2021.

2. The Light Aircraft Company (TLAC) SB 01-2021 was sent via e-mail to all BMAA Inspectors and owners of Escapade and Sherwood Scout aircraft under the airworthiness approval of the BMAA on 31st January 2022.

3. An article regarding adjustable seats and with reference to this particular incident was published in the March 2022 edition of the BMAA Magazine Microlight Flying which is posted to all member of the BMAA. This article also included details about the CAA MPD 2022-004-E and also CAA Safety Notice SN-2022/001.

4. The Escapade Pilot Operators Manual has been up-issued to include specific details about the seat pin and pre-flight checks. Similarly, the Sherwood Scout Pilot Operators Manual has been up-issued by The Light Aircraft Company to include additional details regarding the seat pin and pre-flight checks.

5. Homebuilt Aircraft Data Sheet (HADS) HM12 (Escapade) has been updated to include TLAC SB 01-2021 and also the CAA Mandatory Permit Directive CAA MPD 2022-004-E. The HADS also include details of the new Operators Manual reference, and in Annex E of the HADS Points for Special Attention include details about the seat pin, runner and backup straps.

6. Type Approval Data Sheet (TADS) BM84 (Sherwood Scout) has been similarly updated, and the same actions applied.’

The AAIB has categorised the response to this Safety Recommendation as ‘Adequate – closed’.

Some of the safety issues identified in Special Bulletin S3/2021 and this report apply to other aircraft types on the UK register. Therefore the following additional Safety Recommendation was made:

Safety Recommendation 2021-051

It is recommended that the Civil Aviation Authority in conjunction with the Light Aircraft Association and British Microlight Aircraft Association, remind pilots of the importance of ensuring that seats are correctly locked and any secondary locking mechanisms are correctly used, particularly after any seat adjustment.

The CAA accepted this Safety Recommendation responding with:

> *'The CAA issued general Safety Notice SN-2022/001 on February 17th 2022 to remind pilots of the importance of ensuring all occupied seats are correctly locked in position prior to departure and any secondary locking mechanisms are correctly used. Pilots are encouraged to be familiar with seat adjustment/locking mechanisms in their aircraft, including any backup locking systems and monitor them for wear and proper functioning, particularly following any heavy landing.*
>
> *The CAA has also issued a Mandatory Permit Directive, MPD 2022-004, on February 10th, 2022 applicable to all Reality Escapades and Sherwood Scout aeroplanes (both kit and factory built). The MPD requires inspection of the seat locking and secondary locking means to ensure components are in good condition and working correctly.*
>
> *The inspection is to be performed every 50 flight hours or Annual Inspection (whichever comes first) as well as after any heavy landing. The CAA has worked in conjunction with the Light Aircraft Association and the British Microlight Aircraft Association on mitigation activities for this safety risk. With the agreement and to the satisfaction of the CAA, both the LAA and BMAA have taken appropriate safety actions in relation to this accident and the general safety risk it has highlighted.'*

The AAIB has categorised the response to this Safety Recommendation as 'Adequate – closed'.

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