AAIB
Air Accidents Investigation Branch

AAIB Bulletin 10/2022

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AAIB Field Investigation Reports

A Field Investigation is an independent investigation in which AAIB investigators collect, record and analyse evidence.

The process may include, attending the scene of the accident or serious incident; interviewing witnesses; reviewing documents, procedures and practices; examining aircraft wreckage or components; and analysing recorded data.

The investigation, which can take a number of months to complete, will conclude with a published report.

SERIOUS INCIDENT

Aircraft Type and Registration:	BAe ATP, SE-LPS
No & Type of Engines:	2 Pratt and Whitney Canada PW126A turboprop engines
Year of Manufacture:	1991 (Serial no: 2043)
Date & Time (UTC):	9 April 2021 at 0519 hrs
Location:	Ronaldsway Airport, Isle of Man
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None reported
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	5,415 hours (of which 2,964 were on type) Last 90 days - 44 hours Last 28 days - 20 hours
Information Source:	AAIB Field Investigation

Synopsis

SE-LPS was on approach to Ronaldsway Airport, Isle of Man with the co-pilot as PF. As the aircraft approached the minimum descent altitude, the co-pilot attempted to disengage the autopilot. There was no audio tone to indicate the disengagement and the co-pilot felt there was resistance in the flying controls. Both pilots checked the cockpit indications which seemed to show that the autopilot had disengaged. The commander took control and also felt resistance in the flying controls. He pressed and held the synchronisation (SYN) button on the control column which he felt released the controls and was able to land the aircraft normally.

A definite cause could not be found for the autopilot not disengaging as designed. The manufacturer responsible for the design of the autopilot identified a possible scenario where the autopilot servomotors could remain engaged after the autopilot disengaged. This would result in higher-than-normal forces at the cockpit controls.

On 2 December 2021, another autopilot occurrence on an ATP, registration SE-MAJ, was reported to the AAIB. The results of this investigation are included in this report.

Safety action was taken by the CAA to include additional testing of the autopilot system as part of the continued airworthiness programme of the ATP. The operator took safety action to reconfigure their fleet so that either pilot could override either autopilot via the SYN button on their respective control wheel. The operator also initiated remedial action to try and prevent water ingress into the cockpit.

Two Safety Recommendations have been made to the CAA regarding the use of magnetic tape recorders.

History of the flight

The aircraft departed East Midlands Airport at 0428 hrs for the flight to Ronaldsway Airport, Isle of Man. The co-pilot was PF and was using Autopilot 2 (AP2). The flight was uneventful until the final stages of the approach, apart from the chime which sounds in the flight deck to alert the flight crew that they are approaching the altitude they have set in the Electronic Flight Instrument System (EFIS) Control Panel. Every time the chime sounded, throughout the flight, it lasted for 12 seconds rather than the usual one second.

The crew were radar vectored for an ILS approach to Runway 26 at Ronaldsway. AP2 remained engaged for the approach in localiser and glideslope modes and the crew completed their landing checks. As the aircraft reached the decision altitude, the co-pilot attempted to disengage AP2 using the autopilot disconnect button[1] on his control column. There was no audio warning of a disengagement and when the co-pilot attempted to roll the aircraft to line up with the centreline of the runway, he felt resistance in the movement of the controls.

The co-pilot alerted the commander to the problem and both pilots checked their respective primary flying displays (PFDs) which both indicated the autopilot was disengaged. The commander took control and attempted to adjust the aircraft in pitch and roll, he also felt resistance as if the autopilot was still engaged. The commander then used the SYN button on his control column. He immediately felt the controls were no longer resistant to movement. The commander held the SYN button until the aircraft landed at 0517 hrs.

The commander taxied the aircraft to the parking stand where the autopilot disconnect audio warning began to sound continuously and could not be cancelled by any actions the crew took. It finally silenced when the audio warning unit 'timed out'.

Previous flight

The aircraft's previous flight was on 2 April 2021. The flight was uneventful, but the commander noted that the yaw damper indication on the flight controller panel had extinguished at some point. Prior to shutting the aircraft down, the commander tried to engage each autopilot in turn to see if the anomaly was an indication fault (broken bulb), or a system fault. A post-flight entry in the aircraft technical log stated:

> *'AP controller yaw damper not indicating. AP disconnect sounded continuously after landing. Cannot select AP on ground.'*

Footnote

[1] The following terms are used in this report for consistency but are sometimes referred to by other terms in manuals or checklists:
Autopilot disconnect button (also referred to as pilot disconnect button or disengage switch)
Control column (also referred to as control wheel or control handwheel)
Go around button (also referred to as go around switch)
Flight controller (also referred to as autopilot controller or AP controller)

A replacement autopilot control panel was fitted, and the operator's maintenance facility subsequently found that the yaw damper indication bulb was broken. The aircraft technical log recorded that a replacement AP2 computer was installed.

Recorded information

The aircraft was fitted with a CVR, FDR and a QAR. The data recorded by the QAR was in an identical format to that in the FDR. The AP engaged parameters for AP1 and 2 were the only autopilot parameters recorded. The recording shows AP2 was in use during the approach and disengaged just prior to the decision altitude.

The CVR recording was of high quality and two hours in duration. While it captured the end of the occurrence flight, it remained powered during the initial engineering work and so recordings from the start of the flight, including the pre-flight checks of the AP systems were overwritten. However, the autopilot warnings that triggered after the flight while the aircraft was on the ground were captured. Extracts of the QAR and CVR recordings are shown in Figure 1.

The co-pilot was the PF during the descent. Passing through 250 ft amsl the commander called "DECIDE" and the automatic "MINIMUMS" call was triggered. The data shows that AP2 disengaged, followed by the co-pilot stating that it was "...NOT DISENGAGING..." No cavalry charge audio, normally associated with an autopilot disengagement, was captured by the CVR. This was followed by a brief discussion between the flight crew, during which the PF commented that he felt the AP had not disengaged. Passing approximately 150 ft amsl, the commander stated that he had control, and that he was "IN SYNC MODE". The descent continued and the aircraft landed normally. The commander stated that the aircraft "FELT WEIRD" but that he was in control.

After the aircraft landed, and whilst on the stand, the CVR recorded the crew reviewing the event. The co-pilot stated that he had attempted to disengage the autopilot using the 'button' and also the trim but it had not disengaged. He recalled that he tried to roll the aircraft but that he felt resistance against his attempt to move the control column. The commander stated that it had showed DISCONNECTED on his side.

After the data recorders had stopped, the CVR recorded the pilot saying, "TRY THIS", followed by a series of 24 cavalry charge tones. The co-pilot later recalled that he had engaged AP2 on the ground. The co-pilot then said "YAW DAMPER" which was followed by a series of 11 cavalry charge tones. Shortly after, a series of 255 cavalry charge tones was recorded which the crew seemed unable to stop; the trigger for this was not established.

The CVR stopped recording and started again, capturing engineering discussions about the reported fault. They could not fault the autopilot system, and the normal cavalry charge audio alerts were recorded multiple times. They also stated that the use of the commander's SYN button should not have worked with AP2 engaged.

The only other anomalous system behaviour identified in the recordings were that the altitude alerts recorded by the CVR during the flight were approximately 12 seconds long, which was significantly longer than the expected duration of approximately one second.

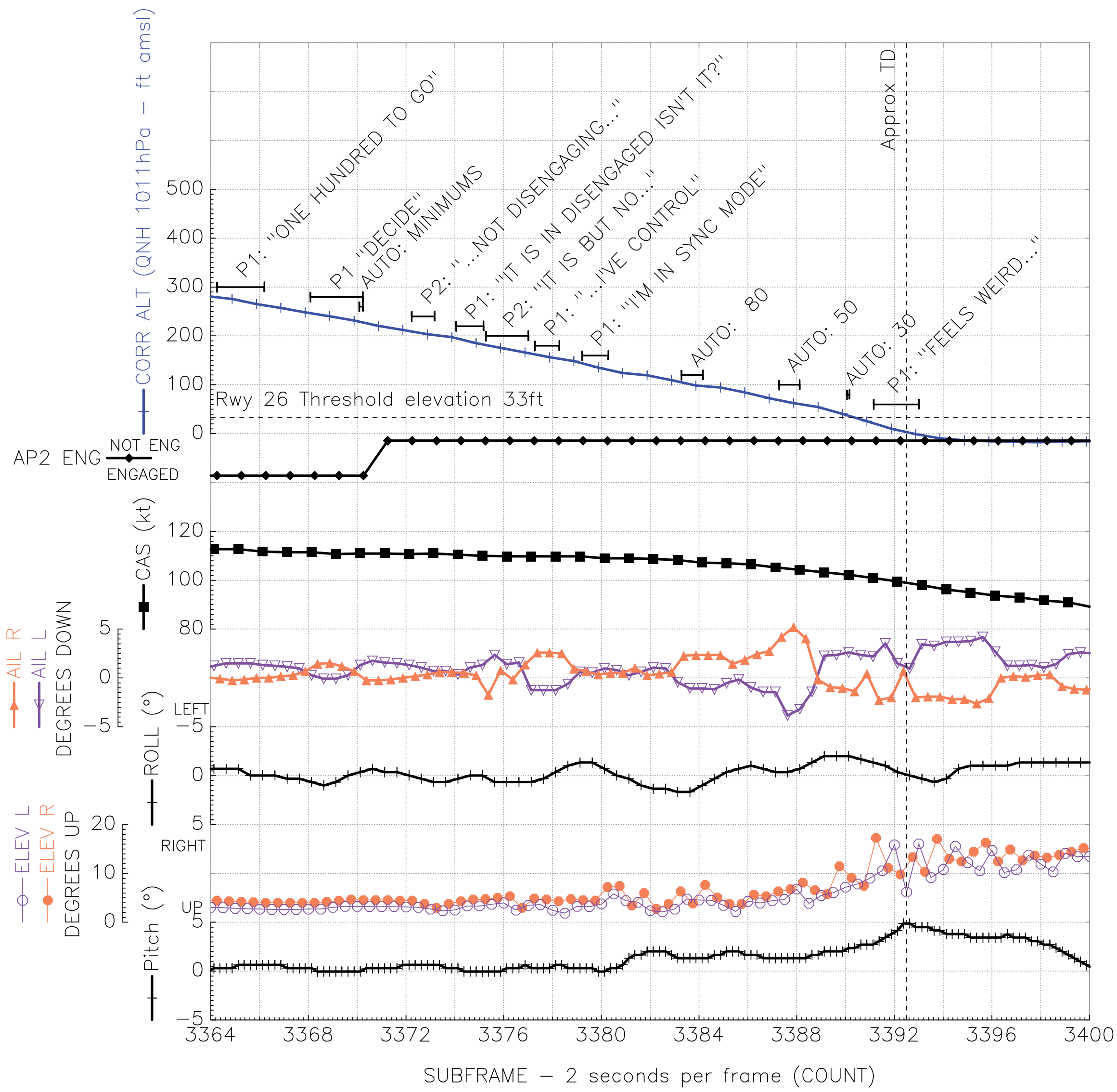


Figure 1

QAR and partial CVR extracts

System descriptions

Automatic Flight Control System

The ATP is fitted with two independent autopilots that share a common flight (autopilot) controller, servo clutches and mechanical drive assemblies. Flight director functions can be selected by each pilot but only one autopilot can be engaged at any one time. The autopilot is a two-axis system (pitch / roll) with a yaw damper and controls the aircraft using three primary electrically actuated servomotors (servos). A separate pitch trim servo operates automatically when the autopilot is engaged or through manual electric trim switches on the control columns. Two independent mode controllers in the centre sloping instrument panel allow the pilots to select autopilot/flight director modes.

Primary servos (aileron, elevator, and rudder)

The three primary servos consist of a drive mechanism with two electric motors (one for each autopilot). The motors are engaged by an electric solenoid clutch that is controlled by the autopilot (flight) controller. A slipping clutch in the servo output lever assembly allows the pilot to override the servo in an emergency. This requires the pilot to apply force on the control column in the direction of the desired movement. For the ailerons this requires a force at the controls of 44 lb (20 kg) and for the elevators a force at the controls of 50 lb (22.7 kg).

Flight controller

The flight controller is fitted to the rear of the centre console and allows the selection of the autopilot system (AP system selector), engagement of the selected autopilot (AP switch) as well as yaw damper disengagement, turbulence mode and ½ bank angle selection. There is also a TURN knob and PITCH wheel which allows the pilot to adjust the aircraft attitude whilst the autopilot is engaged to a new datum or required heading. The controller has an annunciator window that shows the selected functions in green. The controller is shown at Figure 2.

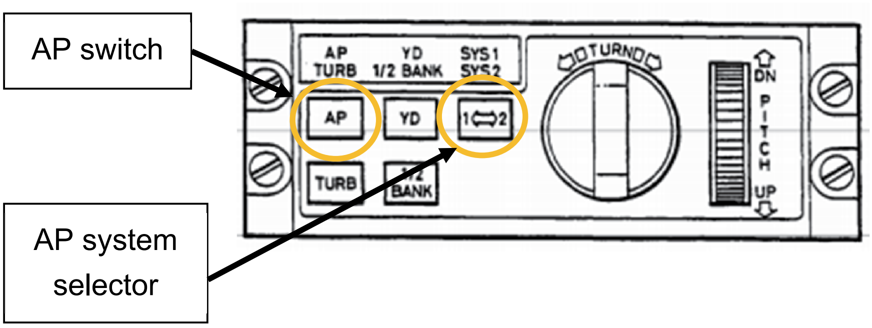


Figure 2
Flight controller © BAE Systems

The AP switch is used to engage the autopilot, but it cannot be used to disengage it. The autopilot will disengage if the AP system selector switch is pressed, because it deselects the active autopilot system and selects the alternate system but in a disengaged state.

Control column

The two aircraft control columns have switches fitted for the control of the autopilot (Figure 3). The co-pilot's control column is similar to the commander's, but with the switches mounted on the opposite side.

The autopilot disconnect button is the primary means for the pilots to disengage the autopilot. Operation of single or both manual electric trim switches on either control column will also disengage the autopilot.

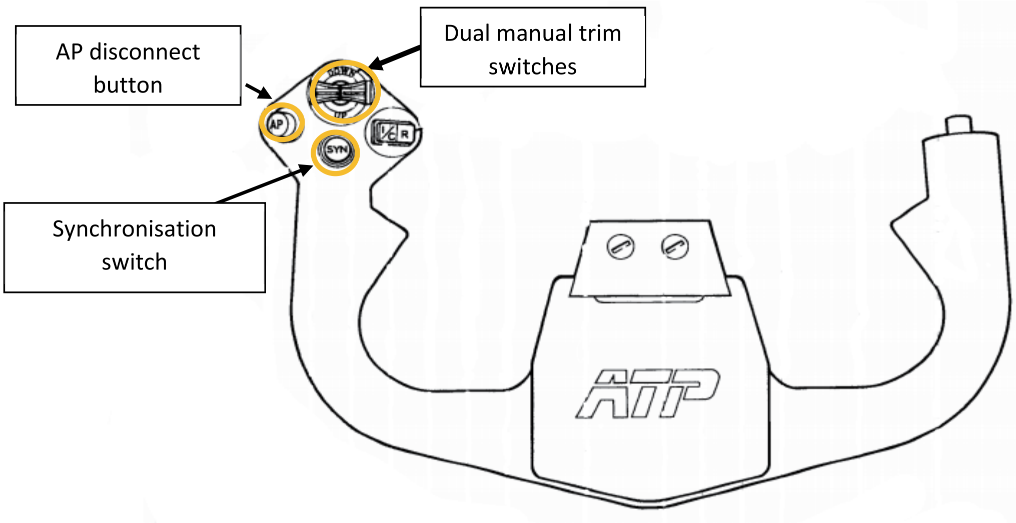


Figure 3
Commander's control column © BAE Systems

The SYN switch is a press button which when depressed will de-clutch the aileron, elevator and pitch trim servos. Any selected autopilot modes will be deselected whilst the switch is depressed. The aircraft may then be manoeuvred to a new attitude with electric trim available without disengaging the autopilot. When the switch is released, the servos re-engage with the flying controls and the autopilot resumes control. Any selected pitch modes are replaced with the basic pitch mode[2] although the previously selected roll mode will reengage if the roll attitude has remained at or less than 6°. The original design of the system allowed either SYN button to de-clutch the servos of either autopilot, allowing either pilot to operate this function regardless of which autopilot system was engaged.

Synchronisation switch

Service Bulletin (SB) 22-14 was issued on 27 April 1990 after an operator request to separate the two SYN buttons so that they only work with their respective autopilot. The operator cited events where the PNF had inadvertently operated the SYN button, disengaging autopilot modes that the PF had previously selected. The SB was optional.

Embodiment of the SB means that the left control column SYN button only works when AP1 is engaged, and the button on the right control column will only work when AP2 is engaged. This SB had been embodied on SE-LPS before the current operator acquired the aircraft, and at the time of this event their ATP fleet consisted of a mixture of modified and unmodified aircraft.

Autopilot engagement and disengagement

The autopilot is engaged by depressing the AP switch on the flight controller (Figure 2). The switch must be depressed for 0.75 seconds to allow for a self-check of the integral safety

Footnote

2 If there are no flight director modes engaged, PITCH is shown on the PFD, which is a basic mode commanding a hold of the current pitch attitude.

circuit to be completed. Once engaged, the status of the autopilot is displayed on the pilot's PFD. If autopilot 1 is engaged, then AP1 in green is displayed in the top centre of the left PFD with AP1 in white on the right PFD. If autopilot 2 is engaged, then AP2 is displayed in green on the right PFD and in white on the left PFD.

The autopilot cannot be disengaged using the AP switch on the controller but can be manually disengaged by the pilots using the following methods:

- AP disconnect button on either aircraft control column (Figure 3)
- Operation of the manual electric trim on either aircraft control column
- Pressing the AP system selector button on the flight controller (Figure 2)
- Pressing either go around switch on the engine power levers

Manual disengagement of the autopilot is indicated by the removal of the displayed AP1 or AP2 on the PFD and by the sounding of an aural warning (cavalry charge) for one second.

The autopilot will disengage automatically if certain failure conditions are detected, or specific aircraft attitude limits are exceeded. If this happens, the cavalry charge will sound continually until the crew press either of the autopilot disconnect buttons, or the cavalry charge sounds 255 times without being cancelled.

Standby Control System (SCS)

The SCS is an emergency system that provides a means of operating the flying controls via the autopilot servos if the primary mechanical flying control circuits are jammed or severed. The SCS control logic is in each autopilot computer so there are two independent systems. The SCS is armed when electrical power is applied to the autopilot circuits, but it is inhibited whilst the autopilot is engaged.

Each SCS has independent channels to control the ailerons, elevator and the rudder. Each channel has a position input sensor (synchro) at the pilot's controls, which is continuously compared with a position feedback sensor (synchro) at the control surface. If the difference between the synchros exceeds a pre-determined limit, and the autopilot is not engaged, the SCS will operate. Under these conditions the relevant servo(s) will be driven to follow the pilot's control demands.

Audio warnings

Audio warnings including the cavalry charge and altitude alert are generated by the audio warning unit. The warning unit is fitted in the cockpit, behind the sidewall trim below the right Direct Vision (DV) window, which can be opened on the ground.

When the autopilot disengages, the audio warning unit generates the cavalry charge tone in response to an electrical input from the autopilot computer. The altitude alert system is active when approaching the selected altitude to within 1,000 ft or if the aircraft deviates from it by 250 ft. If these criteria are met, an amber light illuminates on the altimeter, and the cockpit speaker emits an audible warning tone. The tone is generated by the audio warning unit in response to an electrical input from the air data computer. The tone is 12 seconds long, but it will only sound for the duration of the electrical input, which should be one second. If the electrical input remains active for more than one second, the warning will sound until the input is removed, or the warning unit 'times out' after the tone sounds 255 times.

Aircraft examination

The aircraft operator tested the autopilot, SCS and audio warning system, but no faults were found. The following components were removed for further investigation:

- Flight (autopilot) controller
- Autopilot computer No 1
- Autopilot computer No 2
- Audio warning unit
- Audio summing unit

Equipment testing

Flight controller

The flight controller was tested in accordance with the component maintenance manual and no faults were found. The external cover was removed and there was no visible evidence of any anomalies.

Audio warning unit

The electrical connector was found to be corroded when the audio warning unit was disconnected (Figure 4). The unit is located in the area beneath the DV window and the operator advised that moisture (water) ingress through the DV windows was a known problem with ATP aircraft.

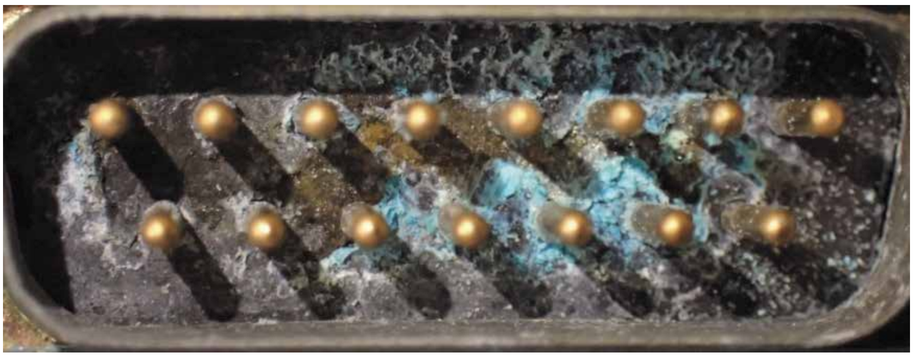


Figure 4

Contamination and corrosion on the audio warning unit connector

No faults were found when the warning unit was tested. It was dry when disassembled, but corrosion deposits were found on one of the three printed circuit boards (PCBs). Most of the corrosion was in the area where the external electrical connector was soldered to the PCB, but deposits were also found on other areas of the circuit board (Figure 5).

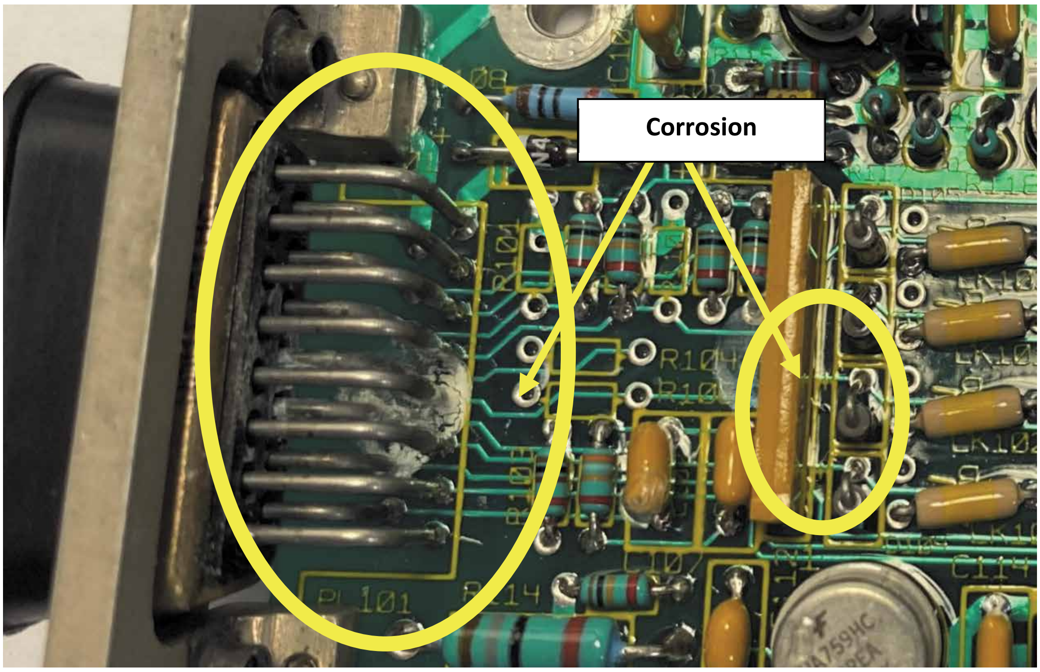


Figure 5

Corrosion deposits inside the audio warning unit

Previous autopilot events and AAIB investigations

The AAIB is aware of three other occasions where flight crews were unable to disengage the autopilot on an ATP aircraft:

- On 27 May 1991 the commander of G-BTPJ was unable to disengage the autopilot. It was eventually disengaged when the crew pulled the autopilot circuit breaker, and a fault was found in the co-pilot's electric trim switch. The AAIB did not investigate this occurrence, and the rationale for the link between the trim switch and the reported symptoms is unclear.
- On 26 January 2016 the crew of G-BUUR reported that the cavalry charge did not sound when the autopilot disconnect button was pressed and control forces suggested that the autopilot was still engaged. The AAIB investigated this occurrence[3] but the cause could not be found. The FDR data indicated that the autopilot disengaged on selection, but the CVR had been over-written.
- On 14 December 2017 the crew of SE-MHF reported that the cavalry charge did not sound when the autopilot disconnect button was pressed

Footnote

[3] Serious Incident on G-BUUR, AAIB Bulletin 9/2016, https://www.gov.uk/aaib-reports/aaib-investigation-to-bae-atp-g-buur [accessed August 2022].

and control forces suggested that the autopilot was still engaged. The control forces were relieved when the co-pilot pressed the SYN button. The AAIB investigated this occurrence[4] but the cause was not found. The FDR data indicated that the autopilot disengaged on selection, but the CVR had been over-written. The aircraft manufacturer reviewed the emergency checklist and a memory item[5] was added stating that if the autopilot does not disengage, the SYN button should be pressed and held whilst manoeuvring the aircraft until it is safe to continue with the rest of the checklist. After the occurrence on SE-LPS, it was noted that the revised checklist did not mention the service bulletin that separates the two SYN buttons so that they will only work if their respective autopilot is engaged. The manufacturer found that this design change had not been identified when the checklist was amended because of an omission during a technical publication amendment in the 1990s. They considered this to be an isolated event that would no longer occur because of subsequent procedural changes.

Review of the autopilot engagement logic

The manufacturer responsible for the design of the autopilot[6] reviewed the engagement logic and identified a possible scenario where an intermittent failure could result in the autopilot computer disengaging whilst the autopilot servo solenoids remain energised.

Each autopilot computer provides the autopilot status signal. The computer that is activated during autopilot engagement indicates the engaged state via this signal. When either of the autopilot disconnect switches are pressed, both autopilot status signals are interrupted, and this interrupt starts the autopilot disengagement sequence.

The autopilot disconnect switches are push buttons that use metallic electrical contacts. These contacts do not connect or disconnect instantaneously but generate an output that indicates that the connection is bouncing until it settles in the final switch state. A debounce circuit is normally used to filter the output so that it represents the desired button status ie ON or OFF.

If the debounce circuit was ineffective, multiple electrical pulses could be produced very rapidly. This phenomenon could be intermittent and could be caused by degradation of electrical components in the debounce circuit or the push button mechanism and contacts.

The autopilot disconnect switches are connected to the autopilot controller, which monitors their status and uses analogue logic gates to control the autopilot computers and servo solenoids (Figure 6).

Footnote

4 Serious Incident on SE-MHF, AAIB Bulletin 12/2018, https://www.gov.uk/aaib-reports/aaib-investigation-to-bae-systems-operations-ltd-atp-se-mhf [accessed August 2022].

5 A memory item is an immediate action that should be completed without needing to refer to the emergency / abnormal checklist

6 The manufacturer responsible for the design is not the Original Equipment Manufacturer

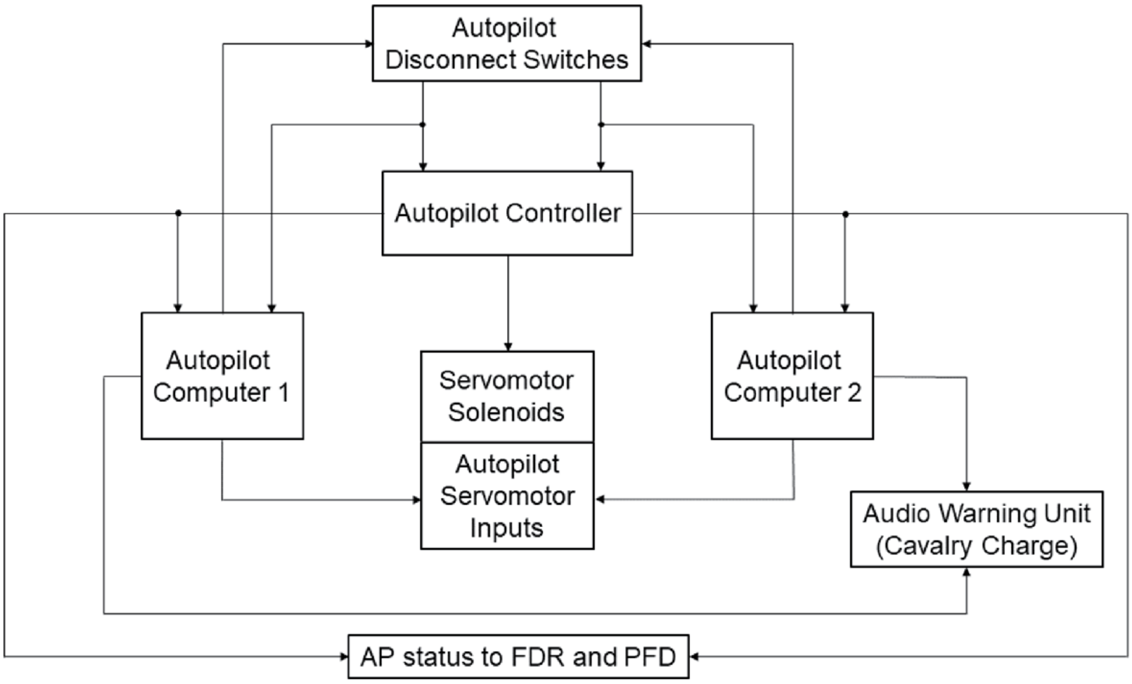


Figure 6

Simplified autopilot schematic (not all components and interactions are depicted)

Unlike digital control circuits, which operate on two voltage levels to indicate ON or OFF, analogue logic gates operate with continuously variable voltage levels, where ON and OFF are represented by specific voltages. These voltages may differ for different components in the circuit, and some components will operate faster than others. Theoretical analysis identified that multiple rapid changes in switch state could potentially result in the autopilot controller logic disengaging the autopilot computer, but not the servo solenoids. The FDR and PFDs would indicate that the autopilot was not engaged, but the crew would experience higher than normal control forces because the servos would still be engaged, but no longer driven by the autopilot. The rapid outputs from the autopilot disconnect switch could cancel the audible cavalry charge before it is generated.

Further attempts to disengage the autopilot using the disconnect buttons or trim switches would have no effect because the autopilot computer would already be disengaged. The only options available to the crew would be to overpower the autopilot servos using the slipping clutches, remove the electrical power by pulling the appropriate circuit breaker, or to de-energise the servo solenoids by pressing the autopilot SYN button.

Meteorology

The weather at Ronaldsway was good with few clouds at 1,500 ft aal and a north-westerly wind of 9 kt. The wind gave a slight crosswind from the right for an aircraft approaching Runway 26. At the time of the occurrence, it was daylight at Ronaldsway, with sunrise occurring at 0531 hrs.

Crew

The commander had significant experience on type and was very familiar with the autopilot system. He had also recently read the AAIB report into a similar occurrence and had spent some time considering his actions should he experience something similar.

Organisational information

Operator procedures

The operator had introduced procedures for checking the disengagement of the autopilots as part of the pre-flight procedures. This was in response to previous occurrences on the aircraft type. This procedure was performed on SE-LPS before the flight and no faults were noted.

Abnormal and emergency checklist procedures

The aircraft Abnormal and Emergency Checklist has a procedure for the crews to follow in the event of an autopilot not disengaging. This checklist was modified after the SE-MHF investigation to include the use of the SYN button. The checklist takes no account of SB 22-14 and does not include any instructions on which SYN button to use if the modification is embodied.

'<u>AUTOPILOT FAILS TO DISCONNECT/MALFUNCTIONS</u>

CAUTION: THE FLIGHT CONTROLS SHOULD BE RESTRAINED DURING DISENGAGEMENT OF THE AUTOPILOT, AS AN OUT-OF-TRIM CONDITION MAY EXIST

If the autopilot does not disengage when the control column disconnect button is pressed:

<u>Memory Actions</u>

Control column SYN button .... Press and hold

Manoeuvre aircraft until safe to continue with the drill

To disconnect the autopilot carry out the following actions until the autopilot disconnects – confirm EFIS PFD AP annunciation extinguishes:

Electric trim	*Operate*
Other control column disconnect button...........................	*Press*
Go-around button	*Press*
SYS1/SYS2 switch..	*Press*
Relevant circuit breaker (see c/b list)	*Pull*

DO NOT RE-ENGAGE THE AUTOPILOT'

Occurrences involving SE-MAJ

2 December 2021

On 2 December 2021 the commander of SE-MAJ, who was also the commander of SE-LPS, reported to the AAIB that the altitude alerts sounded too long, and the cavalry charge did not sound when he pressed the autopilot disconnect button. He recalled that the PFD showed that the autopilot was still engaged after he tried to disengage it. He pressed the disconnect button again, with no effect, before instinctively pressing the SYN button. When he checked the PFD again, the autopilot status showed disengaged. No faults were found when the operator tested the autopilot and audio warning systems, but they replaced several components as a precautionary measure.

Recorded data

QAR, FDR and CVR recordings were analysed and discussed with the crew. The data shows the autopilot disconnected at the point the commander stated he initially attempted to disengage the autopilot, at about 100 ft above the decision altitude. The CVR recording confirmed that no autopilot-disconnect audio alert sounded. The CVR also captured the altitude alerts from earlier in the flight, each sounding for approximately 12 seconds, rather than the normal duration of 1 second. Crew discussions after landing captured by the CVR corroborated the commander's recollection that there was no abnormal resistance to control inputs throughout the event. No other audio alert anomalies were identified from the CVR recording.

29 October 2021

On 29 October 2021 the operator conducted an investigation on SE-MAJ after the crew reported that the altitude alert sounded for too long, and the cavalry charge did not work; the autopilot had disengaged when selected. The operator's engineers found corrosion on the aircraft electrical connector to the audio warning unit and, after removing the corrosion, they reinstalled the original unit. Maintenance records indicated that the engineers believed that the corrosion was probably caused by moisture ingress through the DV window.

Examination of audio warning unit

As the audio irregularities on SE-MAJ were very similar to those on SE-LPS, the audio warning unit from SE-MAJ was returned to the AAIB for further investigation. Visual examination found the external condition to be good but when the external cover was removed the internal components were found to be wet and corrosion was seen on one of the PCBs (Figure 7). This examination was carried out seven days after the occurrence of 2 December 2021, so it is possible that the unit had partially dried out in the intervening time.

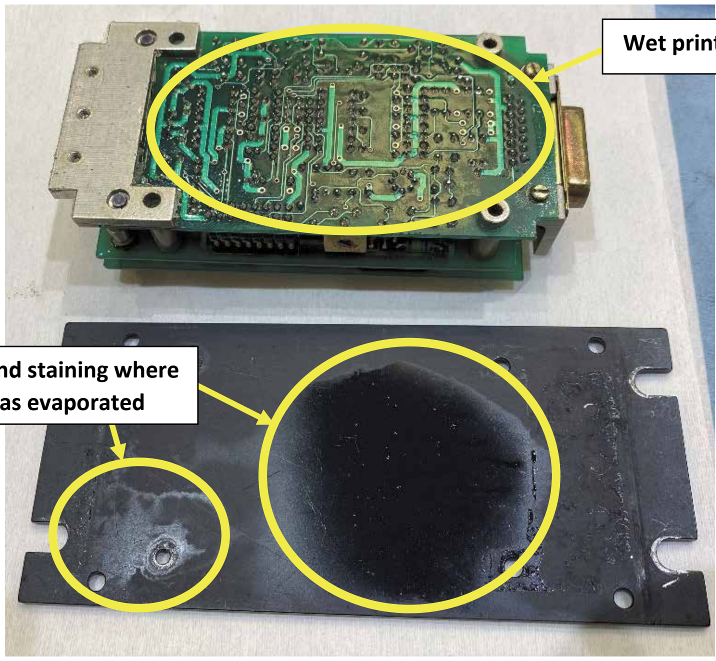


Figure 7
Visible moisture in the audio warning unit

Water ingress via the DV windows

On 16 April 1991 an optional SB (ATP-25-93-35176A) was issued after problems with electrical switches and intercom sockets caused by water ingress through the DV windows. The SB introduced extended side trim panels and drains. However, the operator's ATP fleet consisted of aircraft with and without the SB installed. SE-LPS did not have the SB embodied; SE-MAJ was equipped with the extended side trims, but they were found to be cracked and the joints with the adjacent structure had not been sealed.

Given the condition of the audio warning units that were removed from SE-LPS and SE-MAJ, the operator reported they would take the following safety actions:

- Install the extended side trim panels on all their ATP aircraft and repair any damaged panels.
- Waterproof the side-console switches on all their ATP aircraft.
- Check the rigging of every ATP DV window to make sure that they close correctly.
- Investigate the feasibility of remounting the audio warning unit and installing a drip shield to avoid moisture entering the unit from the top.

FDR recording quality

The FDR fitted to SE-LPS was a model PV1584 which records the data on a magnetic tape. These recorders can suffer from quality issues, resulting in parameter error rates that vary throughout the recording (Figure 8). Errors are expected to occur when recorders stop and start between flights. Additional errors are likely to occur even on a good quality installation.

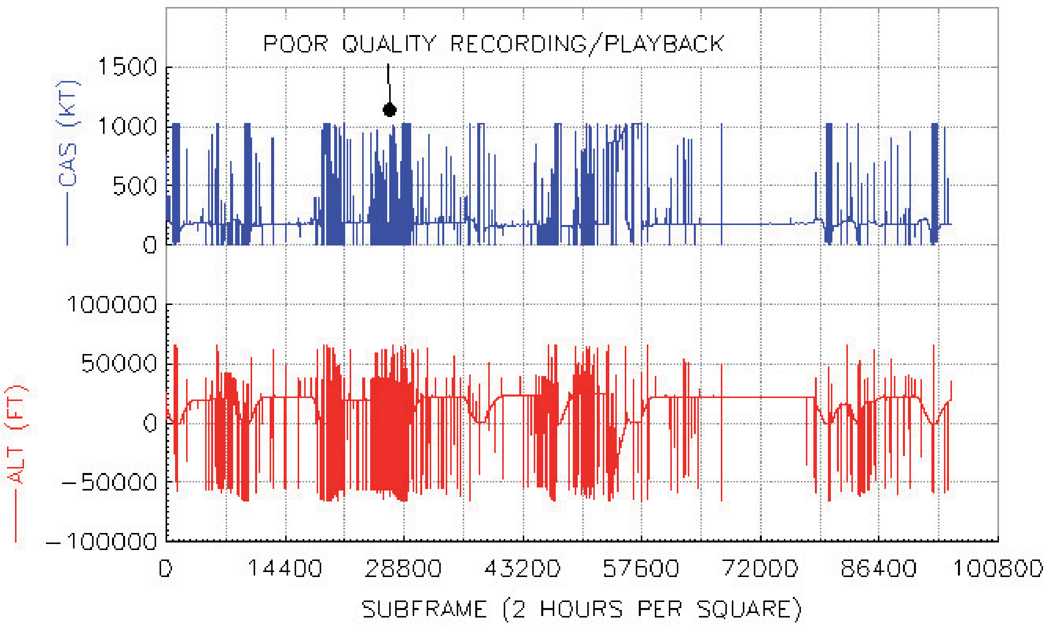


Figure 8

Example parameters illustrating quality issues of magnetic tape FDR recording from SE-LPS

The FDR system on SE-LPS was certified against '*CAA Specification No 10, Flight Data Recorder Systems, dated 1 May 1974*'. An extract from item 3.6.1 of the specification states:

> *'… the design objective for the digital data processing unit and the recorder shall be that not more than one word in 10^4 will be misread under the environmental and operating conditions to which the equipment may be subjected in service. …'*

For a parameter recorded at one sample per second, such as the CAS, a misread of one word in 10^4 equates to a parameter error every 2.8 hours. The CAS data from SE-LPS in Figure 8 indicates a much higher error rate.

When reviewing the quality of the recording, it was seen that some periods of the recording had significantly more errors than others. The recorder records the data in six parallel tracks along the tape using six write heads spaced across the tape. When recording and replaying, one read/write head is used for the full length of the tape and then the tape direction is changed and a different read/write head is used for the next pass. Non-uniformity of the quality of the recording is due to differences in the quality of the read/write heads and variations along the magnetic tape. FDR recorder quality checks do not require the whole recording to be checked.

SE-MAJ was also fitted with the same model of FDR as SE-LPS, and the recording from its occurrence flight also had significant quality issues (Figure 9).

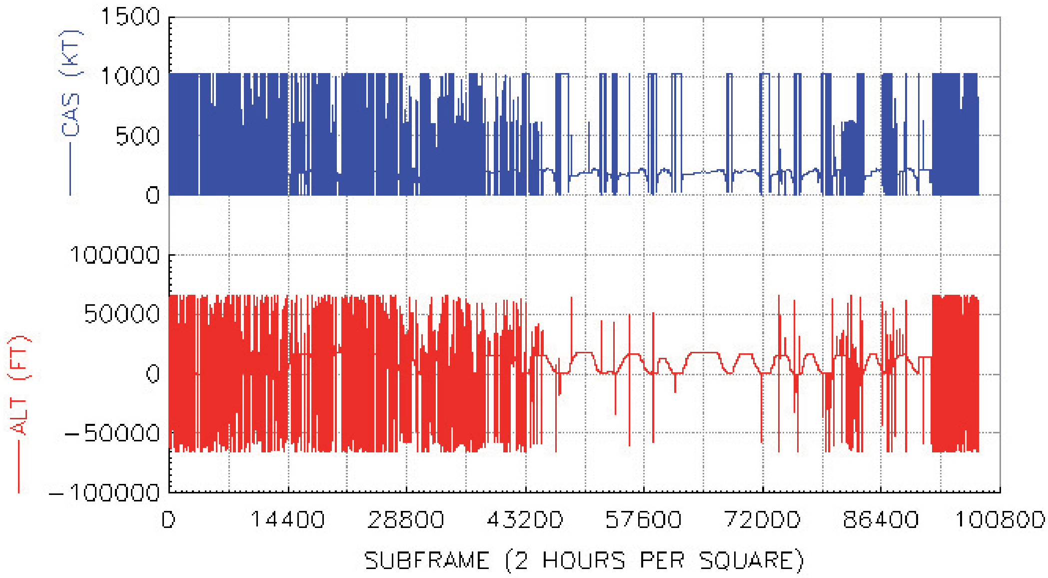


Figure 9

Example parameters illustrating quality issues of magnetic tape FDR recording, from SE-MAJ

For the occurrences on SE-LPS and SE-MAJ, the better-quality recordings of the same data stored in the QAR solid state memories were used in the investigations. This may not be possible in the event of an energetic accident for which crash protected FDRs are designed to survive, whereas QARs are not crash protected. ICAO required magnetic tape FDRs and CVRs to be discontinued[7] by 1 January 2016. EASA reviewed this requirement under '*Notices of Proposed Amendment 2013-26*', which resulted in the prohibition on the use of magnetic tape CVRs but not FDRs: by extrapolation of the reduction in usage, EASA calculated that magnetic tape FDRs would no longer be in use by 2019.

Following an investigation into a serious incident involving an ATP (SE-MHF[8]), which was equipped with a PV1584 magnetic tape recorder, a Safety Recommendation (2019-002) was made by the AAIB to the EASA to bring the European standards into alignment with the ICAO standard that prohibits the use of magnetic tape recorders. The Safety Recommendation states:

> *'It is recommended that the European Union Aviation Safety Agency (EASA) set an end date to prohibit the use of flight data recorders that use magnetic tape as a recording medium, to ensure compliance with ICAO Annex 6 from that date'*

Footnote

[7] ICAO Annex 6 parts I, ref 6.3.1.2 and 6.3.2.2 respectively.

[8] Serious Incident on SE-MHF, AAIB Bulletin 12/2018, https://www.gov.uk/aaib-reports/aaib-investigation-to-bae-systems-operations-ltd-atp-se-mhf [accessed August 2022].

The EASA response was that there were too few installations of this type to pursue and that the issue was not perceived as a safety-of-flight issue. However, magnetic tape recorders are still being used on aircraft beyond the date that EASA believed they would no longer be in service and a number of them have been involved in AAIB investigations. The extent to which magnetic tape flight recorders are used by UK Air Operator Certificate holders is not known; therefore, the following Safety Recommendation is made to the CAA:

Safety Recommendation 2022-014

It is recommended that the Civil Aviation Authority review the use of magnetic tape flight data recorders used in aircraft operated by UK Air Operator Certificate holders and establish if there is a practical way to comply with the ICAO requirement to cease their use.

Given that the quality of magnetic tape recordings can vary significantly throughout the recording, and currently only a quality check of a sample of the recording is required, the following Safety Recommendation is made to the CAA:

Safety Recommendation 2022-015

It is recommended that the Civil Aviation Authority require that magnetic tape flight data recorders, used in aircraft operated by UK Air Operator Certificate holders, comply with the Civil Aviation Authority Specification No 10, regarding the error rate requirements, by checking the complete recording rather than by undertaking a sample check.

Analysis

The investigation could not identify any faults with the autopilot system that could explain the resistance to movement in the flying controls. However, the autopilot manufacturer identified a possible scenario involving an intermittent problem with either the autopilot disconnect switch or the associated debounce circuit in the autopilot controller. Corrosion was found in the audio warning unit which may have caused the extended duration of the altitude alert warnings.

Audio warnings

The crew reported anomalies with the altitude alert during the flight and the cavalry charge sounded repeatedly on SE-LPS after it landed; it also sounded repeatedly after the previous flight. The aircraft electrical connector to the audio warning unit was found to be corroded and corrosion was also found inside the warning unit.

Corrosion was also found within the warning unit fitted to SE-MAJ and the PCBs inside were wet. The combined effect of the corrosion and moisture cannot be readily assessed. However, given the similarities between the symptoms on both aircraft, it is likely that this contributed to, or caused, the extended duration of the altitude alerts and the repeated cavalry charge warnings on SE-LPS after it landed. The DV windows, which can be opened when the aircraft is on the ground, are known to be susceptible to water ingress. Previous SBs have been issued to reduce the likelihood of aircraft equipment being affected by moisture ingress, but SE-LPS did not have these SBs embodied. The SBs embodied on SE-MAJ were found to be incomplete, and damaged, and would not have prevented water leaking through the DV window reaching the audio warning unit.

Autopilot

The autopilot manufacturer suggested that rapid electrical pulses might have occurred when the disconnect button was pressed, resulting in the autopilot computer disengaging whilst the servo solenoids remained energised. While the FDR and PFD would show that the autopilot was disengaged, the rapid pulses would cancel the cavalry charge before it had time to sound. The forces at the control column would be greater than normal, and the only way the crew could overcome these forces would be to either over-power the slipping clutch, press the SYN button, or remove electrical power from the autopilot by pulling the CB.

Whilst this scenario could explain the two similar occurrences on G-BUUR and SE-MHF, it could not fully explain the crew's account of the event on SE-LPS. In the case of SE-LPS, the commander reported that the excessive forces dissipated when he pressed his SYN button. The modification standard of the aircraft, however, meant that this should not have been possible.

The AAIB considered the possibility that the autopilot disengaged normally when the co-pilot pressed the disconnect button, but that the lack of the audible cavalry charge led the pilots to believe that it remained engaged. However, since both pilots felt resistance in the controls, and the commander reported that the resistance stopped when the SYN button was pressed, the possibility that the autopilot disengaging normally is considered unlikely.

The autopilot manufacturer identified additional testing to substantiate their theoretical failure scenario. If successful, this could result in changes to minimise the future arising rate. Safety action was taken by the CAA to include the proposed testing as part of the ongoing continued airworthiness of the ATP fleet.

The operator has removed SB 22-14 from all their aircraft, so that that both SYN buttons will override either autopilot.

Crew response to autopilot anomalies

The commander's significant experience on type as well as his knowledge of the previous AAIB report into a similar event meant that he was prepared to use the SYN button. The co-pilot's effective communication that he was experiencing difficulties with disengaging the autopilot also meant the commander understood rapidly what the issue was and was able to take appropriate action. As a result, the aircraft landed safely from the approach.

The crew tried both autopilot disconnect buttons and electric trims in accordance with the abnormal/emergency checklist without success. Whilst they did not try either the go around button, or the AP system selector button, it is considered unlikely that these actions would have released the servomotor solenoids. Whilst the design of the aircraft autopilot system allows the pilot to gain control of the aircraft through the use of the slipping clutches, this requires them to apply significant force on the flying controls. The significant forces involved could have presented the pilots with a demanding manoeuvre as the aircraft was close to the ground.

Conclusion

The investigation concluded that the anomalies with the audio warnings were probably associated with corrosion and moisture caused by water ingress through the DV windows.

The AAIB was unable to replicate the reported anomalies in the autopilot system, but theoretical analysis by the autopilot manufacturer identified a scenario involving the autopilot disconnect button and the associated debounce circuit that could lead to a partial disengagement of the autopilot. This scenario could explain the previous occurrences on G-BUUR and SE-MHF but would only partially explain the occurrence to SE-LPS.

Although the aircraft abnormal and emergency checklist did contain a procedure for the failure of the autopilot to disengage, the commander reacted instinctively due to his awareness of a previous occurrence that he had read about in an AAIB report. While the slipping clutch is designed to allow the crew to overpower an autopilot that does not disengage, a substantial increase in the force required to operate the flying controls when late on the approach could present an increased safety risk to the aircraft. The commander used the SYN button which allowed him to operate the controls without hindrance and land the aircraft without further incident.

Safety actions

A s a result of this serious incident the following safety actions were taken:

- The aircraft operator took the following safety actions:
  - Restored the original SYN button logic on all their ATP aircraft.
  - Included the use of the SYN button to overcome the autopilot for all crew in a simulator session in early 2022.
  - Review the water ingress SBs on all their ATP aircraft. The SBs will be incorporated and repaired as necessary.
- The CAA will consider the investigation findings as part of their ongoing review of the ATP continued airworthiness.

Safety Recommendations

The following Safety Recommendations were made to the CAA:

Safety Recommendation 2022-014

It is recommended that the Civil Aviation Authority review the use of magnetic tape flight data recorders used in UK airspace and establish if there is a practical way to comply with the ICAO requirement to cease their use.

Safety Recommendation 2022-015

It is recommended that the Civil Aviation Authority ensure that magnetic tape flight data recorders, used in UK airspace, comply with the Civil Aviation Authority Specification No 10, regarding the error rate requirements, by checking the complete recording rather than by undertaking a sample check.

Published: 25 August 2022.

ACCIDENT

Aircraft Type and Registration:	1) Cessna 182B, G-OMAG 2) Boeing Stearman A75N1(PT17), N68427
No & Type of Engines:	1) 1 Continental Motors Corp O-470-R piston engine 2) 1 Continental Motors Corp W670 piston engine
Year of Manufacture:	1) 1959 (Serial no: 52214) 2) 1942 (Serial no: unknown)
Date & Time (UTC):	20 August 2021 at 1332 hrs
Location:	Dunkeswell Aerodrome, Devon
Type of Flight:	1) Private 2) Private
Persons on Board:	1) Crew - 1 Passengers - None 2) Crew - 1 Passengers - None
Injuries:	1) Crew - 1 (Serious) Passengers - N/A 2) Crew - None Passengers - N/A
Nature of Damage:	1) Damage to wings and control surfaces, windscreen, window, cabin structure and engine cowling. Fin and rudder tops chopped off, and damage to elevators. 2) Damage to propeller and shock load to engine. Cuts in fabric of fuselage and damage to right wing root.
Commander's Licence:	1) Commercial Pilot's Licence 2) Private Pilot's Licence
Commander's Age:	1) 66 years 2) 72 years
Commander's Flying Experience:	1) 3,801 hours (of which 1,759 were on type) Last 90 days – 12 hours Last 28 days – 6 hours 2) 2,878 hours (of which 161 were on type) Last 90 days – 13 hours Last 28 days – 4 hours
Information Source:	AAIB Field Investigation

Synopsis

N68427 was completing a circuit at Dunkeswell Aerodrome when it landed on top of G-OMAG on the runway. G-OMAG had joined the circuit from the dead side and positioned ahead of N68427 on final for Runway 22. Neither pilot saw the other aircraft, nor were they alerted to the presence of the other by radio transmissions until late on the final approach.

Following this accident, the CAA published a Supplementary Amendment to CAP 452 to improve the situational awareness of pilots operating at aerodromes providing an Air to Ground Communication Service.

History of the flight

At 1300 hrs on the day of the accident, the pilot of G-OMAG (the Cessna) took off from Bodmin Aerodrome en-route to Dunkeswell Aerodrome to deliver the aircraft to its owner following an annual inspection. He had obtained 'prior permission' from the aerodrome operator and was expected by their staff. At 1305 hrs, the pilot of N68427 (the Stearman) took off from Dunkeswell, his home base, for a flight in the local area. After takeoff he departed the circuit to the north, maintaining a listening watch with Dunkeswell Radio.

The weather was reported by various witnesses to be 'workable' with overcast cloud at 1,200 ft above the aerodrome and patches of lower cloud at 600 to 800 ft above surface level in the vicinity of Dunkeswell. Cloud bases were reported to be above 3,000 ft amsl to the north. Visibility was approximately 5 km and the wind was light from the south-west.

At around 1326 hrs the Cessna was north abeam Exeter and the pilot informed Exeter Radar that he was continuing with Dunkeswell Radio. He established communications with Dunkeswell Radio, requesting the airfield details. A radio operator informed him that Runway 22 was in use, with a QFE of 986 hPa.

At approximately the same time, the Stearman re-joined the Dunkeswell circuit from the east and positioned on a left base for Runway 22. The pilot reported that he made a radio call indicating his intention to join the circuit but could not recall receiving an answer. None of the aerodrome operator's staff who were present in their office could remember with any certainty either hearing, or responding to, this radio call.

At 1329 hrs, the Stearman completed a touch-and-go landing and continued into the left-hand visual circuit, achieving a downwind height of 750 ft. The Cessna was now approximately one nautical mile to the west and the pilot made a track change to the left, onto a northerly heading, to arc around the aerodrome to position to join the circuit from the dead side[1] onto a right base for Runway 22 (Figure 1).

G-OMAG

The Cessna pilot reported that he continued toward final approach at approximately 600 ft aal and when established on final transmitted "golf alpha golf final *22*". He reported that no radio calls were heard after his initial contact with Dunkeswell Radio and that he believed he was joining an empty circuit. Following a normal powered approach at approximately 70 mph, the Cessna landed just beyond the displaced threshold, intending to turn off at the runway intersection. The groundspeed was allowed to decay and the flaps were retracted. With around 100 m to go to the intersection, the pilot reported that he heard and felt what seemed

Footnote

[1] The dead side is the side of an active runway away from that of the circuit pattern in use. In this case, Runway 22 with left hand circuits was in use, therefore the right side of the circuit was the dead side.

like an "explosion" and then became aware of propeller blades rotating in front of his face. He recalled that the cockpit was filled with debris from the shattered windshield, shards of metal and splintered wood.

Figure 1

Tracks of G-OMAG joining the circuit and N68427 touch-and-go circuit sourced from recorded data

N68427

At the point the Cessna was approximately one nautical mile from the runway threshold, CCTV footage (Figure 2) showed the Stearman flying a curving left base leg, descending from downwind. The pilot was not aware that the Cessna had joined the circuit and had heard no radio transmissions.

The pilot reported that he made a radio transmission as he started the base leg, then again when established on final. He then heard a final call from another aircraft and, assuming it was an aircraft positioning behind him, made an information call: "November 27 final, close to threshold". There was no response from the other aircraft, so he continued with the approach. CCTV footage (Figure 3) showed that the Cessna had passed ahead of, and below, the Stearman before the Stearman had completed the base turn. Various witnesses reported seeing both aircraft on the final approach in very close proximity, "as though they were in formation" (Figure 4).

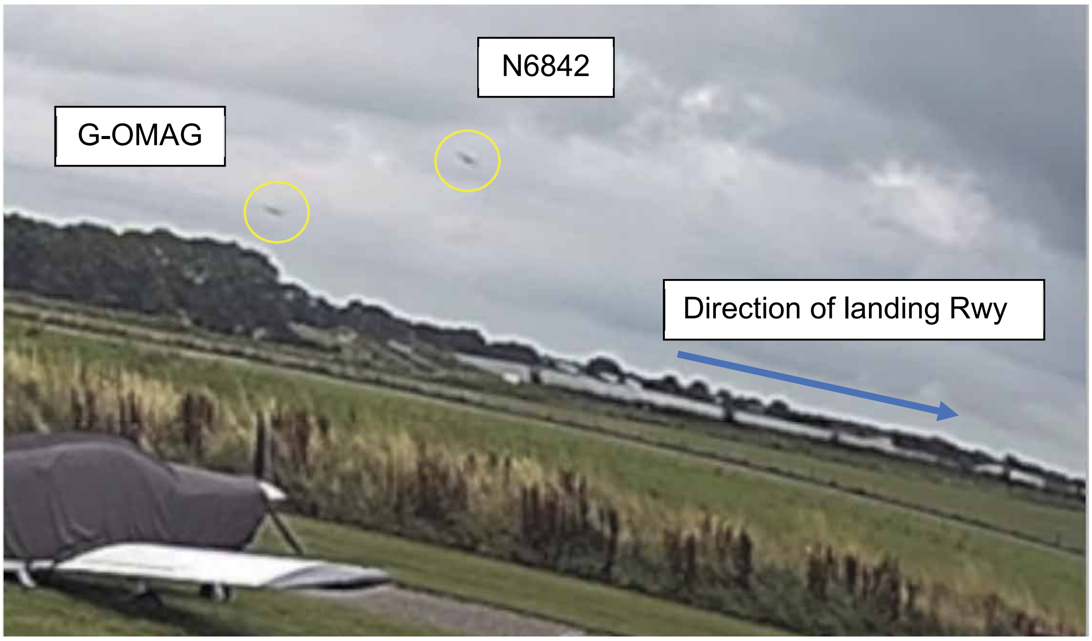


Figure 2

Still from CCTV footage of the approach to Runway 22
(image used with permission)

Figure 3

Stills from CCTV footage of the approach to Runway 22
(image used with permission)

Figure 4

Aircraft on final approach
(images used with permission)

The pilot reported that the landing "didn't feel right" and that the aircraft was not responding to control inputs. He applied power to correct what he felt was a drift to the left, then reduced power to idle. The aircraft continued to swing further to the left, off the runway and onto the grass (Figure 5).

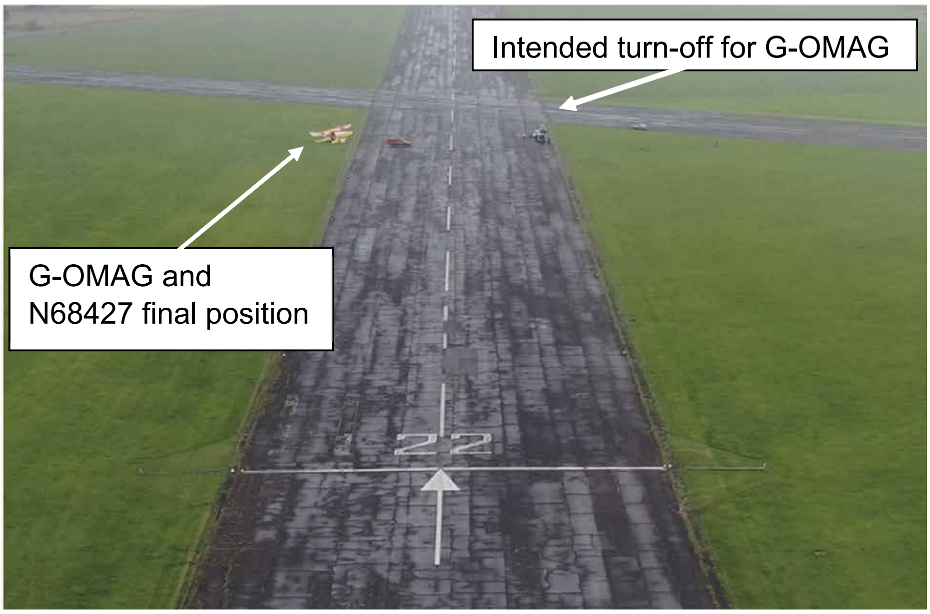


Figure 5

Facing inset threshold of Runway 22
(image used with permission)

The pilot believed that the left landing gear had failed. Once the aircraft stopped, he looked down and saw that his aircraft was straddled on top of another aircraft, the Cessna (Figure 6).

Figure 6

Looking back to threshold of Runway 22
(image used with permission)

Post-collision

The pilot of the Cessna shut down the aircraft and attempted to exit but found that he could not open the door. The pilot of the Stearman had already exited his aircraft and assisted him to egress by forcing open the door.

A member of the operator's staff who had seen the proximity of the aircraft during the final stage of their approach, and believing that a crash was imminent, activated the crash alarm. The aerodrome Rescue and Fire Fighting Service (RFFS) fire tender arrived quickly at the site of the collision and gave first aid to the pilot of the Cessna, who had sustained significant injuries to his torso, limbs and head. They also doused the aircraft with foam and water as fuel was leaking from the left wing tank of the Cessna. After a short time, emergency services arrived on site and the pilot of the Cessna was taken to hospital.

Aerodrome information

Dunkeswell aerodrome is located on the Blackdown Hills in Devon, 14 nm north-east of Exeter, at an elevation of 839 ft amsl (Figure 7). It is owned and operated by a private company. The aerodrome is licensed by the CAA for operations for the purpose of public transport or flying training activity in accordance with the Air Navigation Order; at other times it operates as an unlicensed aerodrome.

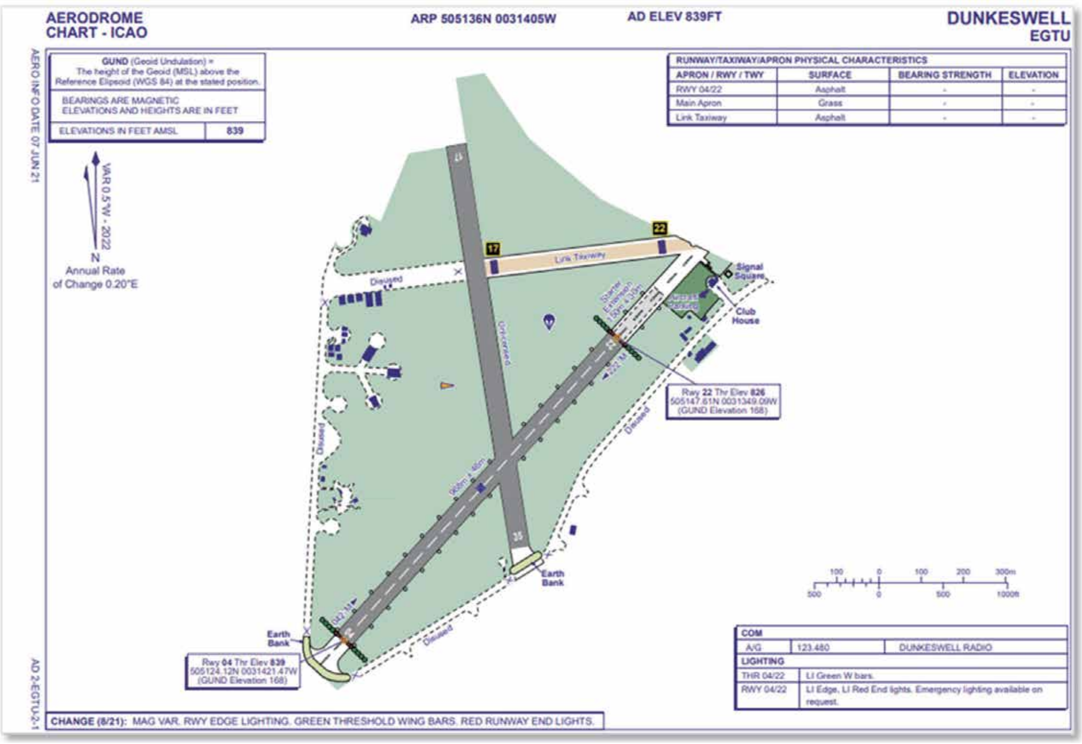


Figure 7

Dunkeswell Aerodrome (from NATS AIP)

Aerodrome procedures

For inbound flights not normally based at Dunkeswell, prior permission is required (PPR), which can be obtained through a dedicated page on the operator's website. The website has a page providing information to visiting crews on local operating procedures. Alternatively, a PPR can be sought over the telephone with the aerodrome operator.

The web page provides the following information:

> *'Joining Instructions*
>
> *Both Fixed Wing and Helicopters to join either on downwind or base leg for the runway in use. Circuit height 800ft.*
>
> *Runway 22 Left Hand circuits…*
>
> *Further information is available in the AIP.'*

The Cessna pilot stated that he had visited Dunkeswell approximately 30 times since 2012 and was aware of the local procedures.

The Air Information Publication (AIP)[2] entry for Dunkeswell contains the following information:

'EGTU AD.2.22 FLIGHT PROCEDURES

1 CIRCUITS

> *a. Circuit directions: Runway 04 – RH; Runway 22 – LH. Circuit height: 800 FT.*
>
> *b. No overhead joins due to parachuting.*
>
> *c. No straight in approaches.*
>
> *d. No orbits in the circuit or on final approach, ie extend downwind or go around.'*

The operator was not aware that the AIP entry did not contain reference to the requirement for inbound traffic to join the circuit via either the downwind or base legs of the active runway. Where the AIP entry omits key information, that omission would also be reflected in charts from commercial providers such as Pooleys, as their data for licensed airports and aerodromes is sourced from the AIP. Accordingly, the operator decided to ensure that information contained on Dunkeswell Aerodrome's website was accurately recorded in the relevant NATS AIP entry.

Footnote

2 The UK Civil Aviation Authority is responsible for the form and content of UK Aeronautical Products, and NATS, as the UK Aeronautical Information Service Provider, is responsible for the preparation and availability of the products in the AIP. Available: https://nats-uk.ead-it.com/cms-nats/opencms/en/Publications/AIP/ [Accessed May 2022].

Aerodrome operator

Provision of Air to Ground Communication Service

The operator held a licence to provide an Air to Ground Communication Service (AGCS) in accordance with the Wireless Telegraphy Act 2006 and the Air Navigation Order 2016 (ANO) Article 205. The level of service an operator provides is based on factors such as the number of aircraft movements, projected movements and types of operations being conducted. The operator communicates this to the CAA through an Aerodrome Manual, which provides an exposition of their operation. The CAA considers the appropriateness of the intended level of service based on the history of the operation, safety reports and information received from users in the General Aviation community, among other factors. The safe conduct of the operation is then monitored during periodic audits by the CAA.

The operator's Aerodrome Manual stated that an AGCS was available '*on request'* and would be provided during opening hours of 0830 to 1700 hrs, as promulgated in the AIP. The operator stated that the AGCS would be manned for "98%" of the time during notified hours and that pilots could "expect to be answered if they call during operating hours". However, they acknowledged that when staff became busy with other duties this might not always be the case.

The Aerodrome Manual did not contain guidance or standard operating procedures for radio operators providing the AGCS but relied on transfer of knowledge from one to another to verbally convey operating procedures and culture. There was no process to establish who had responsibility to actively monitor the AGCS frequency, or to handover the watch if a staff member had to engage in other duties. The CAA currently provides no guidance material to the operator of an AGCS on the conduct of the service[3].

Radio Operator's Certificate of Competence

An individual must hold a Radio Operator's Certificate of Competence (ROCC) if they are providing an AGCS. The ROCC is a document issued by the CAA after an applicant has passed written and practical examinations that demonstrate their competence to operate an aeronautical radio station safely and correctly. The CAA publishes CAP 452, '*Aeronautical Radio Station Operator's Guide',* which contains details of the syllabus for the examination but does not cover guidance for the running of an AGCS. The CAA does not currently approve any training courses associated with the issue of a ROCC.

Two members of the operator's staff held a current ROCC; both individuals were working on the day of the accident. The radio operators did not normally pass details of traffic in the circuit, only the runway in use and pressure setting (see Footnote 3). The operator reported that it might not always be possible for the radio operators to know if aircraft were in the circuit, so they would not always be able to provide accurate information.

The AGCS frequency was not recorded and was not required to be by regulations.

Footnote

[3] This subject is covered in more detail under the section 'Regulations for AGCS'.

Radio transmissions made by the pilots

Both pilots stated that they made appropriate radio calls when joining, and while flying in the circuit. Of these calls, only the Cessna pilot's call when joining the circuit was established as being acknowledged by a radio operator on the ground. Witness evidence indicated that the following radio calls made by the pilots were heard, but it was not possible to establish the order of transmission:

- Stearman – Final call.
- Cessna – Final call.
- Stearman – second Final call with position update.

Regulations for AGCS

CAP 452, together with CAP 413, '*Radiotelephony Manual*', are intended to provide '*the main reference documents for radio station operators*'. CAP 452 states that:

> *'AGCS radio station operators provide traffic and weather information to pilots operating on and in the vicinity of the aerodrome. Such traffic information is based primarily on reports made by other pilots. Information provided by an AGCS radio station operator may be used to assist a pilot in making a decision; however, the safe conduct of the flight remains the pilot's responsibility;'*

and that:

> *'AGCS is to be made available to aircraft during notified hours.'*

While not defined in CAP 452, the CAA stated that an AGCS should comprise appropriate and serviceable radio equipment with trained and qualified radio operators to operate it. For the AGCS to be considered available during notified hours, the CAA advised that the radio operator should be focused on the task of delivering the service without undue distractions, such as extra administrative duties. Also, constant service provision should be available within notified hours unless promulgated otherwise. Neither CAP 452 nor CAP 413 provides this guidance to the licence holder on the delivery of an AGCS. The CAA advised the AAIB that a review of CAP 452 was underway, including wider aspects of the conduct of AGCSs, but could not provide a timescale for the implementation of a revision.

Further information can be found in CAP 168, '*Licensing of Aerodromes*', where an operator who provides a RFFS must provide '*a method of monitoring the aircraft movement area for the purpose of instantaneously alerting and deploying'.* The operator considered this requirement satisfied by the combination of the visibility of the aerodrome from the office, monitoring of the aerodrome frequency and the provision of a crash alarm button in the office.

Aerodrome inspections by the CAA

A periodic on-site audit was conducted at Dunkeswell by the CAA in January 2019 to verify continued compliance with national licensing requirements. There were no comments or instances of non-compliance recorded regarding the provision of an AGCS.

Skyway Code

The CAA publishes *'The Skyway Code*', which is intended to provide General Aviation pilots with practical guidance on all operational, safety and regulatory issues relevant to their flying. Under the section '*Aerodrome Operations*' it states that:

> *'Correct understanding and use of procedures is important for safe aerodrome operations. Most GA aerodromes are 'uncontrolled', meaning pilots must operate safely amongst other airspace users, without direction from air traffic control.'*

In a later section on general circuit guidance, it provides the following advice:

- 'A*s a general rule, joining traffic must give way to traffic already established in the circuit.*
- *Keep a good look out, knowing the conflict areas for the particular join you are conducting.*
- *Conform to the standard pattern.*
- *Announce your position at the standard points and whenever you feel it will enhance the situational awareness of others.*
- *Even if you do not believe there to be any other traffic around, continue to announce your position and intentions as 'blind calls' – you never know when other aircraft might appear. Non-radio aircraft are also a possibility.*
- *If you believe the circuit is clear but are not sure, there is no harm in asking over the radio whether there is any other traffic – it is not unknown for pilots to stop making position calls if they believe they are alone in the circuit.*
- *When one aircraft is overtaking another, the aircraft being overtaken has right of way.'*

The Rules of the Air Regulations

The Rules of the Air Regulations requires the following actions to be taken by pilots when flying at a national licensed aerodrome with an AGCS:

> *'If there is no flight information centre at the aerodrome the commander must obtain information from the air/ground communication service to enable the flight to be conducted safely within the aerodrome traffic zone.'*

When flying within an aerodrome traffic zone, the commander must:

> *'if the aircraft is fitted with means of communication by radio with the ground, communicate the aircraft's position and height to the air traffic control unit, the flight information centre or the air/ground communications service unit at the aerodrome (as the case may be) on entering the aerodrome traffic zone and immediately prior to leaving it.'*

Aircraft handling aspects

Like other aircraft of similar configuration, the Stearman's forward fuselage restricts the pilot's forward and downward view during approach and landing. Due to weight and balance considerations, it is flown from the rear seat when solo. To allow sufficient vision of the landing area ahead, the pilot must sideslip towards the runway, keeping the threshold in sight until the aircraft is straightened just before the landing flare. The pilot stated that when circuit conditions allowed, he preferred to fly a curving base leg onto final to improve his visibility of the runway and to avoid having to apply sideslip during a longer, straight, final leg. This is a technique often employed by pilots in similar types.

Analysis

Overview

N68427 descended onto G-OMAG on the runway at Dunkeswell Aerodrome while attempting to land. Neither pilot was aware of the presence of the other in the circuit until late in the final approach, nor their precise positions. Both pilots were qualified and current, and their respective radios were serviceable, evidenced by the fact they had both been in communication with either an ATC unit or an AGCS radio operator at times on the day of the accident.

N68427

The pilot of the Stearman was based out of Dunkeswell and was familiar with local operating procedures. When he re-joined the circuit on a left base for Runway 22, some 21 minutes after taking off, he believed the circuit was clear. The pilot could not recall his joining call being answered and of the two qualified radio operators on the ground, neither could remember either hearing the call or replying to it. His decision to fly a curving base leg on his first and second approaches was based on the well-known limitations on forward visibility in the Stearman and his belief that his was the only aircraft in the circuit. The geometry of his turn and the flightpath of the Cessna beneath him, made it unlikely that the pilot would have visually acquired the Cessna if he was not primed with the knowledge of its presence by radio. Neither would he have been expecting an aircraft to join the circuit from the dead side. While he had no reason to anticipate an aircraft landing ahead of him, at an uncontrolled aerodrome it is important for pilots to always remain vigilant to the possibility of the presence of other aircraft, as advised in the Skyway Code. Timely and accurate radio calls enhance pilot awareness of the air traffic environment and improve the probability of the 'see-and-avoid' principle being effective in avoiding collisions.

G-OMAG

The pilot of the Cessna stated that he had visited Dunkeswell approximately 30 times in the previous 10 years and was familiar with the local procedures. Although the aerodrome's website stated the requirement to join the circuit on either a downwind or base leg of the active runway, the AIP and Pooleys entry for the aerodrome did not have this information. This highlights the importance for airfield operators to be diligent in sharing all relevant data with the CAA and NATS to ensure the AIP, as the definitive source of aerodrome information for pilots, correctly reflects local procedures. Pilots must also be diligent in familiarising themselves with procedures at aerodromes they intend to visit.

When the pilot contacted Dunkeswell Radio stating his intention to join the circuit, he was not informed of the presence of the Stearman joining from the east, and he did not hear other radio calls. The investigation could not determine the order that joining calls were made by the two aircraft. At the point the Cessna was approximately one nautical mile to the west of the aerodrome and changed course to the north to arc around to join from the dead side, the Stearman was established in the circuit and had just completed a touch-and-go. Guidance in the Skyway Code is clear that, as a general rule, joining traffic must give way to traffic already in the circuit, but that relies on timely position reporting by pilots and adherence to procedures.

AGCS

The aerodrome operator was licensed to deliver an AGCS and there were two employees present on the day of the accident who held ROCCs. The operator did not have a documented process for allocating specific watch periods for the radio operators but adopted an informal practice where the radio frequency would be monitored when duties allowed. Additionally, the radio operators did not normally pass traffic information to aircraft, only the runway in use and pressure setting. The ANO states that when flying within an aerodrome traffic zone, a pilot must:

> *'…communicate the aircraft's position and height to the air traffic control unit, the flight information centre or the air/ground communications service unit at the aerodrome (as the case may be) on entering the aerodrome traffic zone and immediately prior to leaving it.'*

Had a nominated and qualified member of staff been actively monitoring the AGCS frequency as their primary function, without undue distractions of other administrative duties, they would have been aware of the presence and intentions of the two aircraft. Therefore, it is likely that they would have been able to alert each aircraft to the presence of the other based on their position reports. While the Skyway Code is clear that the responsibility for safe operation at an uncontrolled aerodrome rests with individual pilots, visual acquisition of aircraft is more likely if primed with the knowledge of their presence by timely radio calls by the AGCS operator.

Guidance for AGCS radio operators

The CAA informed the AAIB that it had an expectation for AGCS radio operators to be focused on the task of delivering the service without undue distractions, such as extra administrative duties. This was not an expectation shared by the aerodrome operator and is not included in CAP 452. CAP 452 states that an AGCS is to be made available during notified hours, and the CAA's expectation is that constant cover will be available within those hours unless promulgated otherwise.

The approved Aerodrome Manual contained no guidance on the delivery of the AGCS, and there had been no comments or indications of non-compliance in the most recent periodic audit by the CAA. The AAIB was informed by the CAA that work was currently in progress to review the scope of CAP 452 and the wider aspects of the AGCS, and this was expected to address the apparent gap between regulatory intention and practice. CAPs are subject to periodic revision to take account of changes to source regulatory material, feedback from industry, and recognised best practice. However, this process takes time to implement, and therefore to address the issues ahead of the revision to CAP 452, the CAA took the following Safety Action:

On 4 August 2022, the CAA published Supplementary Amendment 2022/01 to CAP 452 *Aeronautical Radio Station Operator's Guide* providing an update to requirements for holders of a Radio Operator's Certificate of Competence. The Amendment included the following provision:

- AGCS/OCS shall be provided to aircraft during the notified hours of operation. **Notified hours are as published in the AIP or promulgated via other means. Aerodrome operator's must be notified on occasions where AGCS/OCS cannot be provided during the hours of operation.*
- If no answer received outside of these notified hours the use of blind transmissions is required.
- It is important that the radio operator should be free from distractions and keep additional admin tasks to an essential minimum.
- Compulsory read-back of those ATS messages specified in the Radiotelephony Manual (CAP 413) paragraph 2.70 are required.
- Information reported by pilots including position reports may only be used in a retransmission as an aid to assist other pilots in their lookout and safe operation of the aircraft. They are not to be assumed correct/incorrect or to be challenged by the AGCS/OCS operator.
- Any information provided by the ROCC operator does not relieve the pilot-in-command of an aircraft of any responsibilities.

Conclusion

N68427 collided with G-OMAG while landing at Dunkeswell Aerodrome because the pilot was not aware that G-OMAG had joined the circuit from the dead side and positioned ahead of him. The pilot of N68427 did not see G-OMAG, possibly because the relative positions of the two aircraft meant that G-OMAG was obscured from view by N68427's structure. The pilot of G-OMAG had not been passed information from the AGCS radio operator on the presence of N68427 and had not seen it in the circuit.

The CAA published a Supplementary Amendment to CAP 452 to improve the situational awareness of pilots operating at aerodromes providing an AGCS.

Published: 25 August 2022.

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).

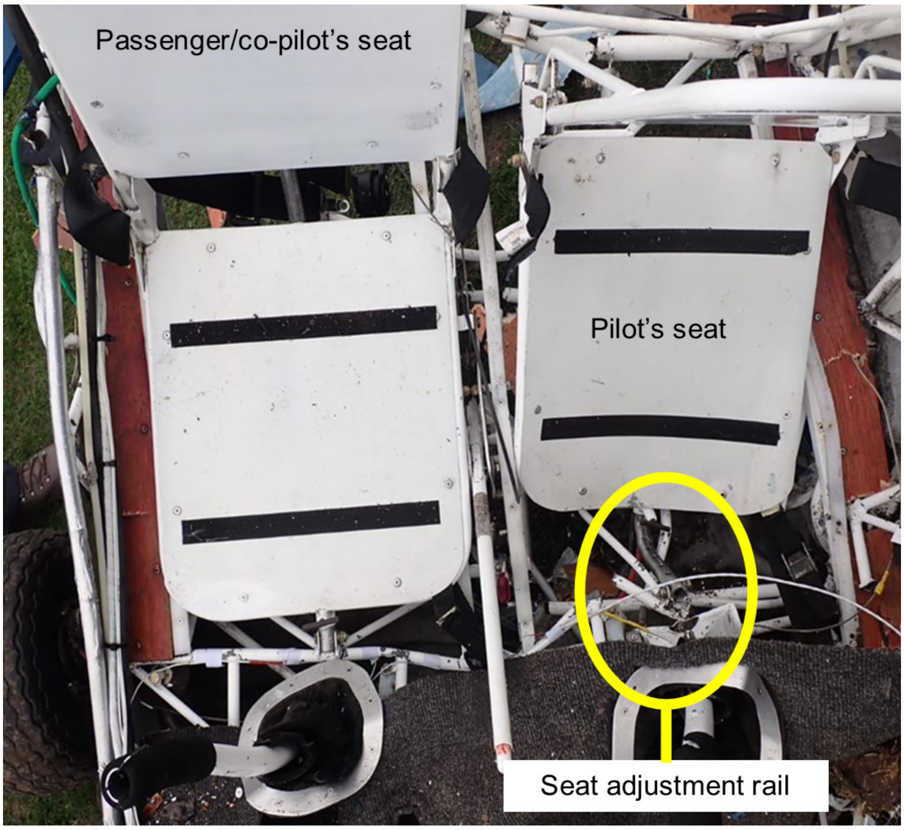


Figure 1

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).

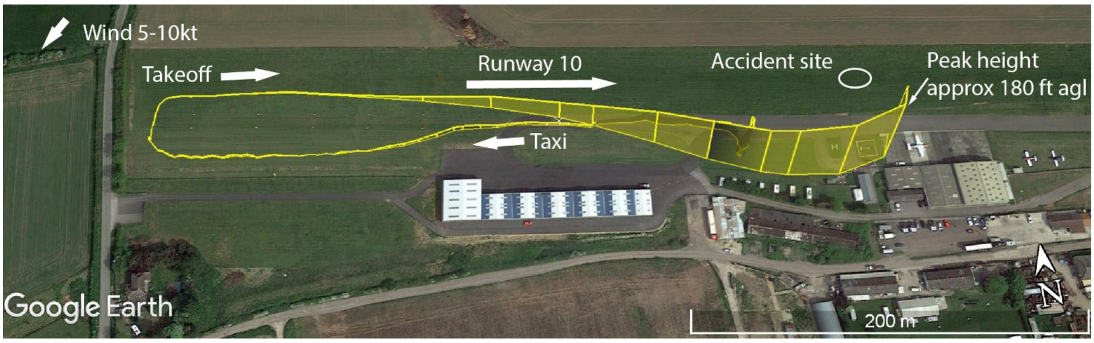


Figure 3

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

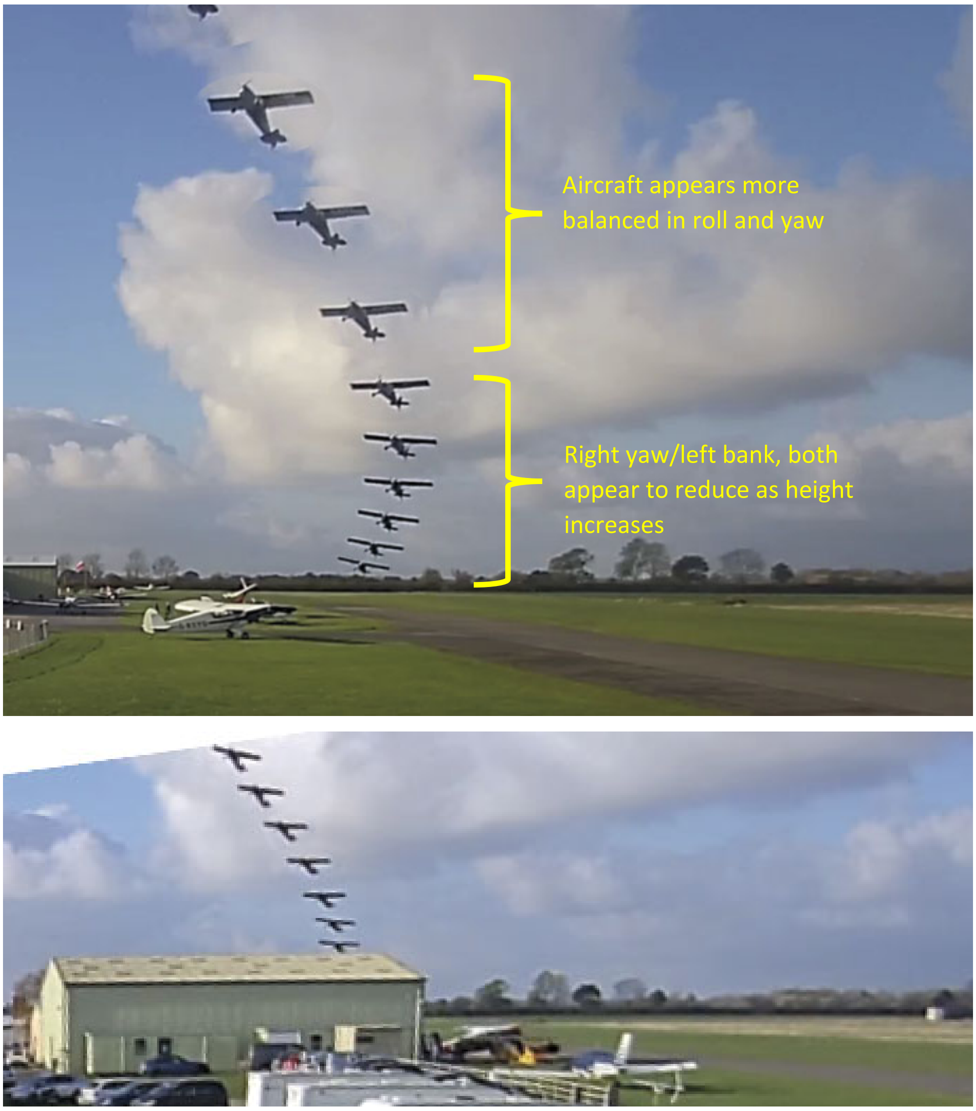


Figure 4

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.

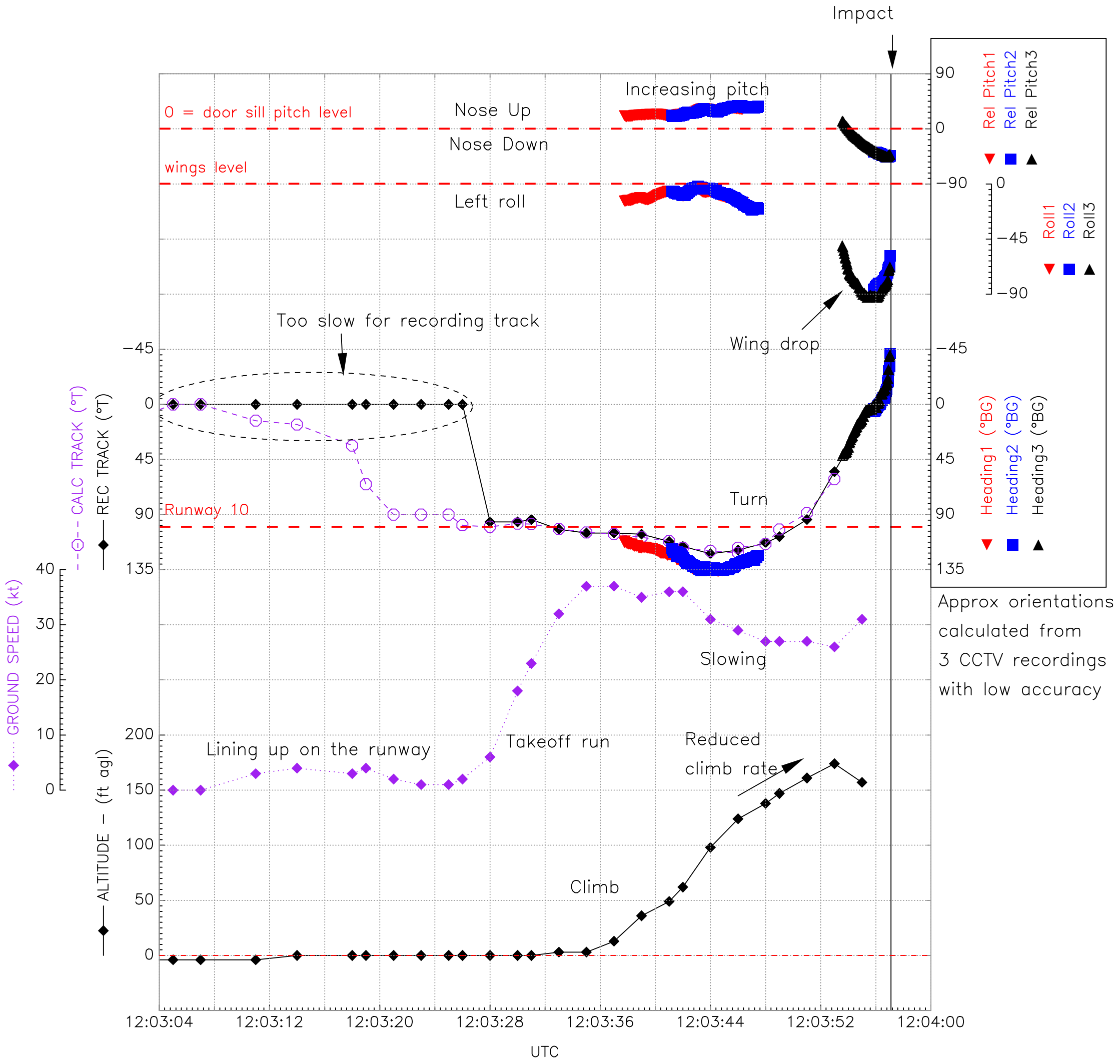


Figure 5

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.

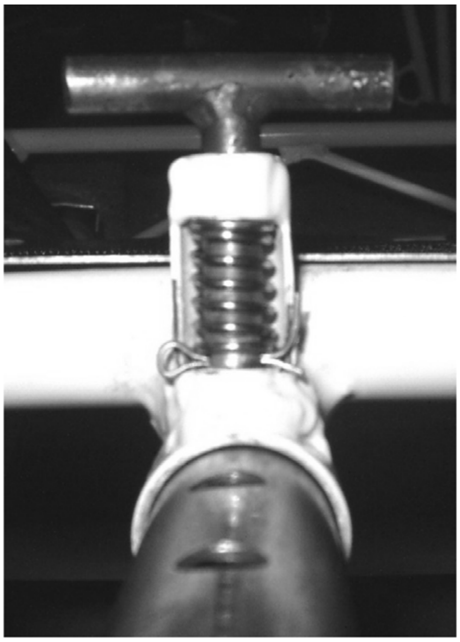


Figure 7

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.

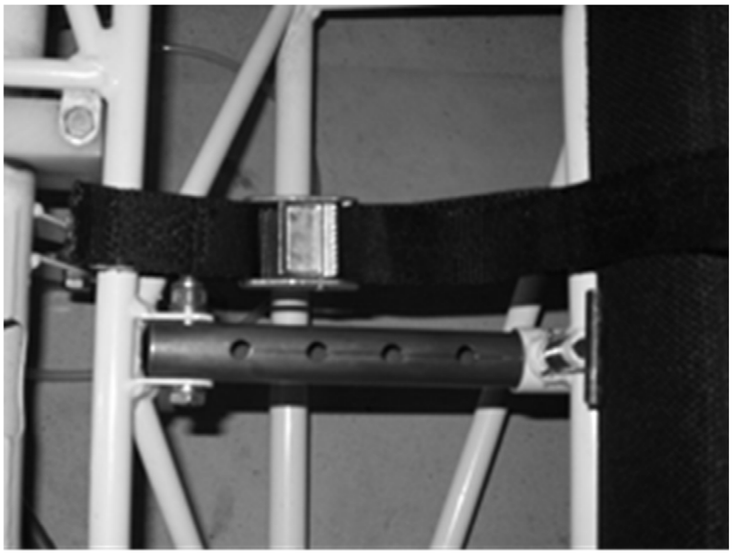


Figure 8

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.

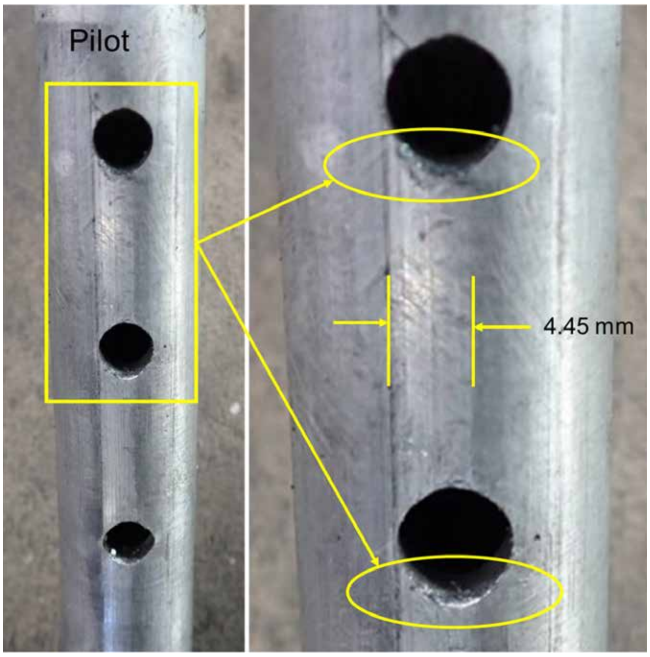


Figure 9

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.

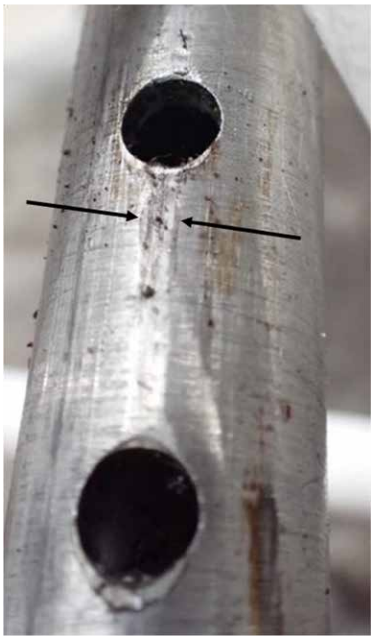


Figure 10

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

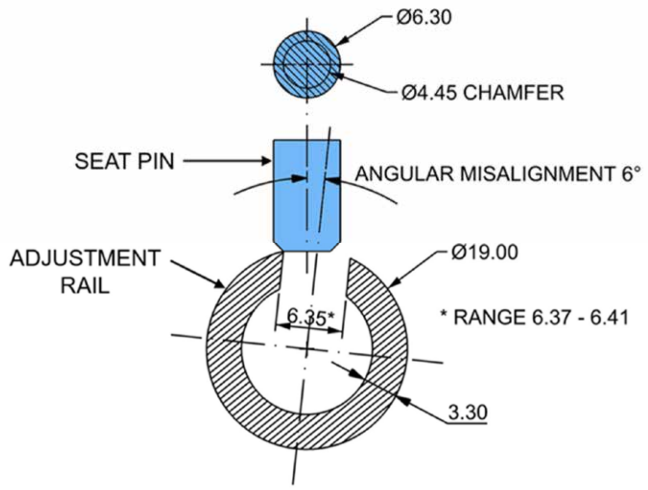


Figure 12
Schematic cross-sectional diagram of the adjuster rail dimensions and pin offset (not to scale)

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.

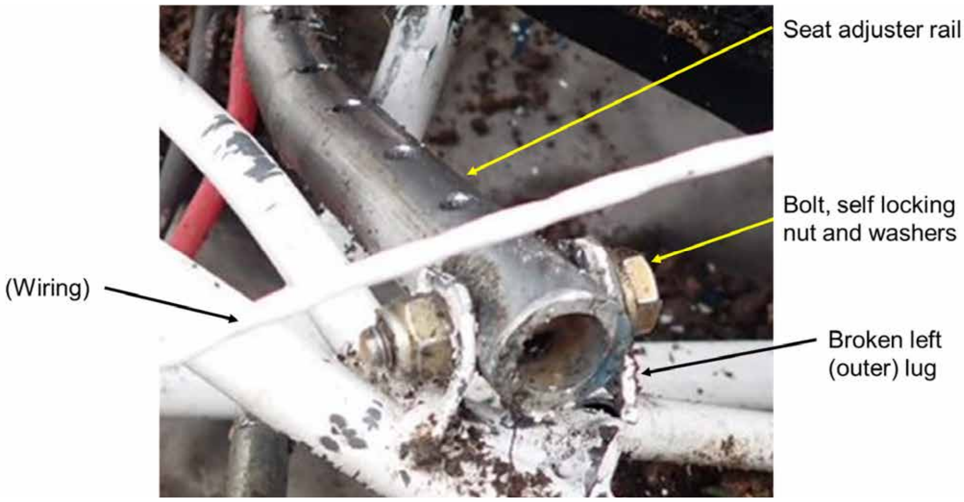


Figure 13

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).

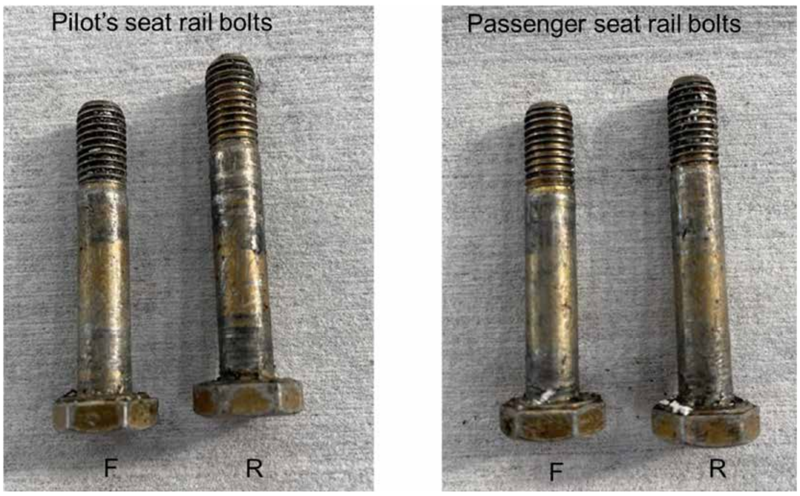


Figure 14

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).

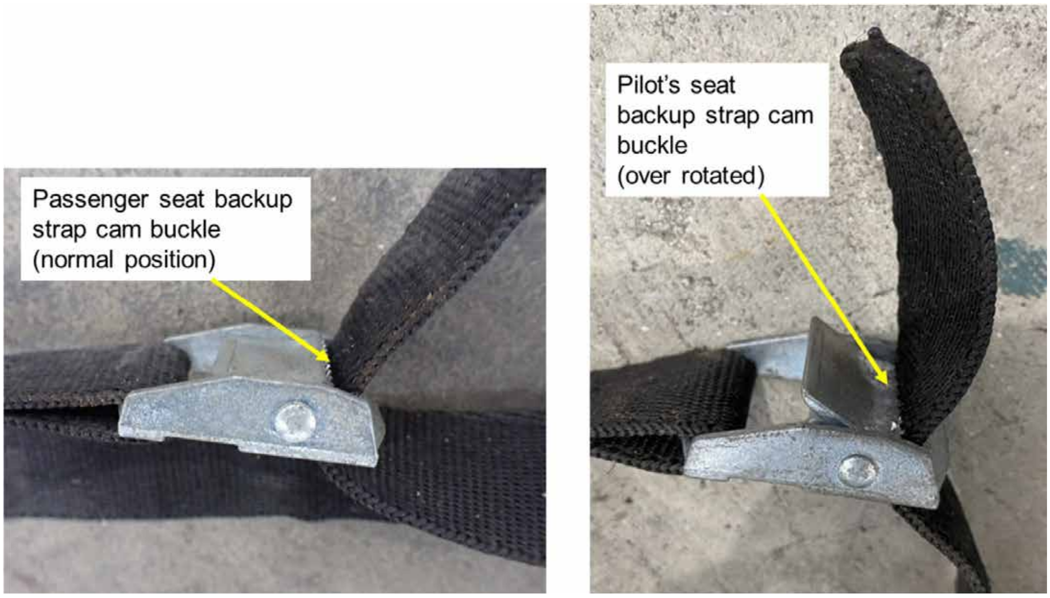


Figure 15

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.

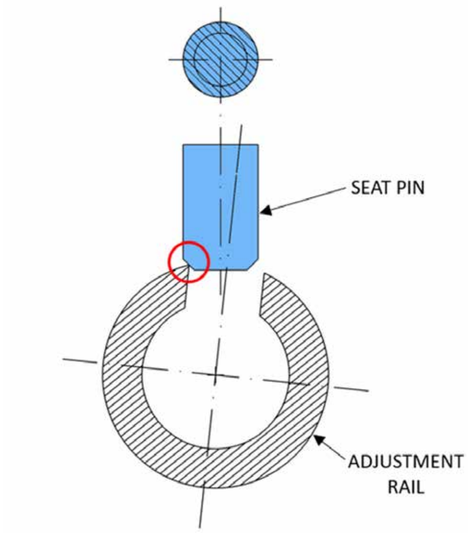


Figure 17

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'.

Published: 22 September 2022.

AAIB Correspondence Reports

These are reports on accidents and incidents which were not subject to a Field Investigation.

They are wholly, or largely, based on information provided by the aircraft commander in an Aircraft Accident Report Form (AARF) and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

SERIOUS INCIDENT

Aircraft Type and Registration:	Bombardier Challenger CL-600-2B16 (601-3A), 2-PAPA
No & Type of Engines:	2 General Electric Aviation CF34 turbofan engines
Year of Manufacture:	1993 (Serial no: 5125)
Date & Time (UTC):	29 March 2022 at 1638 hrs
Location:	On approach to Oxford Airport
Type of Flight:	Private
Persons on Board:	Crew - 3 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	8,550 hours (of which 2,000 were on type) Last 90 days - 59 hours Last 28 days - 36 hours
Information Source:	Aircraft Accident Report Form submitted by the commander and further enquiries by the AAIB

Synopsis

The flight crew were flying a non-precision approach to Oxford Airport. As the aircraft passed the Final Approach Fix, in IMC, a high rate of descent was established leading to a GPWS terrain warning. As the aircraft emerged from cloud the commander reduced the rate of descent and elected to continue the approach. The aircraft landed normally.

There was insufficient data to determine with certainty why the high rate of descent occurred but it was likely to be due to the way the Flight Management System (FMS) was used to fly the approach. The operator's procedures required the crew to initiate a maximum gradient climb following a GPWS warning in IMC and a go-around following an unstable approach or high rate of descent on approach, but neither occurred. Fatigue and miscommunication may have been contributory factors.

History of the flight

2-PAPA was being flown from Guernsey to Oxford Airport. This was the second flight of the day and was preceded by a four hour wait on the ground in Guernsey. The previous day the crew had flown the aircraft from Nassau in the Bahamas to Bristol Airport via St John's Airport in Newfoundland.

The aircraft took off from Guernsey Airport at 1515 hrs and proceeded towards Oxford. The crew were expecting to fly the NDB/DME approach to Runway 01 at Oxford. The weather conditions at the airport were a surface wind from 050° at 8 kt, visibility 8 km, and cloud broken at 700 ft aal and overcast at 800 ft aal. Approaching the airport the crew were given a shortened routing taking them direct to the Compton VOR then direct to the Oxford NDB. When they contacted Oxford Approach, they were given a radar vector toward the Final Approach Fix (FAF).

The crew descended and slowed the aircraft, levelling at 1,800 ft amsl just prior to the FAF, with the gear up and flap 20 set. At this stage the autopilot was engaged and the aircraft was in IMC. As the aircraft approached the FAF the co-pilot reported that the commander changed the selected altitude to zero, pressed VNAV[1] on the flight guidance panel and asked him to select the gear down and flap 30. As the aircraft passed the FAF, the commander reported that he asked the co-pilot to select a 'vertical direct to the runway' in the FMS. The aircraft then started to descend rapidly. The co-pilot remembered seeing a rate of descent of 2,200 fpm to 2,500 fpm but recalled the FMAs[2] were correctly reading 'LNV' and 'VPTH'. He reported that he called "vertical speed" but the commander did not remember hearing this call. Both pilots then heard a GPWS warning, the commander recalled hearing 'TERRAIN TERRAIN' whereas the co-pilot recalled hearing 'TERRAIN TERRAIN, PULL UP PULL UP'. The commander was confident he did not hear 'PULL UP'.

The pilots' recollection of the next few moments differed. The commander recalled that following the GPWS warning he disconnected the autopilot and started to reduce the rate of descent. He thought that they broke out of cloud at between 1,000 ft and 900 ft amsl. He remembered seeing the runway, seeing four red PAPI's and being approximately 300 ft below the correct vertical profile. He decided to continue the approach. He recalled the co-pilot calling "altitude" and ATC warning them that the aircraft was low. He recalled levelling the aircraft to regain the profile and continuing the approach for a normal landing.

The co-pilot recalled that immediately following the GPWS alert he called "go-around flaps". He did not get a reply from the commander so called 'go-around' again. He stated that the commander did not physically or verbally acknowledge these calls. He recalled that the aircraft broke out of cloud passing approximately 700 ft amsl and the commander then disconnected the autopilot and started to reduce the rate of descent. The co-pilot recalled stating 'go-around' again. He remembered the commander saying "why would I go-around when I am visual with the runway?". He replied "we are below the profile and very low". The co-pilot recalled ATC stated the aircraft was low and asked if they were happy to continue and commander replied he was happy to continue. The co-pilot remembered stating "we are 200 ft above the ground with four reds" but the commander continued the approach.

The aircraft landed on Runway 01 at 1638 hrs. There was no damage to the aircraft.

Footnote

1 VNAV – Vertical Navigation.
2 FMA – Flight Mode Annunciator.

Recorded information

The aircraft was fitted with a FDR but no data was recovered from it. Data broadcast by the aircraft was used to create Figure 1. The profile flown by 2-PAPA is shown in blue and the published NDB/DME approach profile is shown in orange. The terrain under the approach path is shown in green.

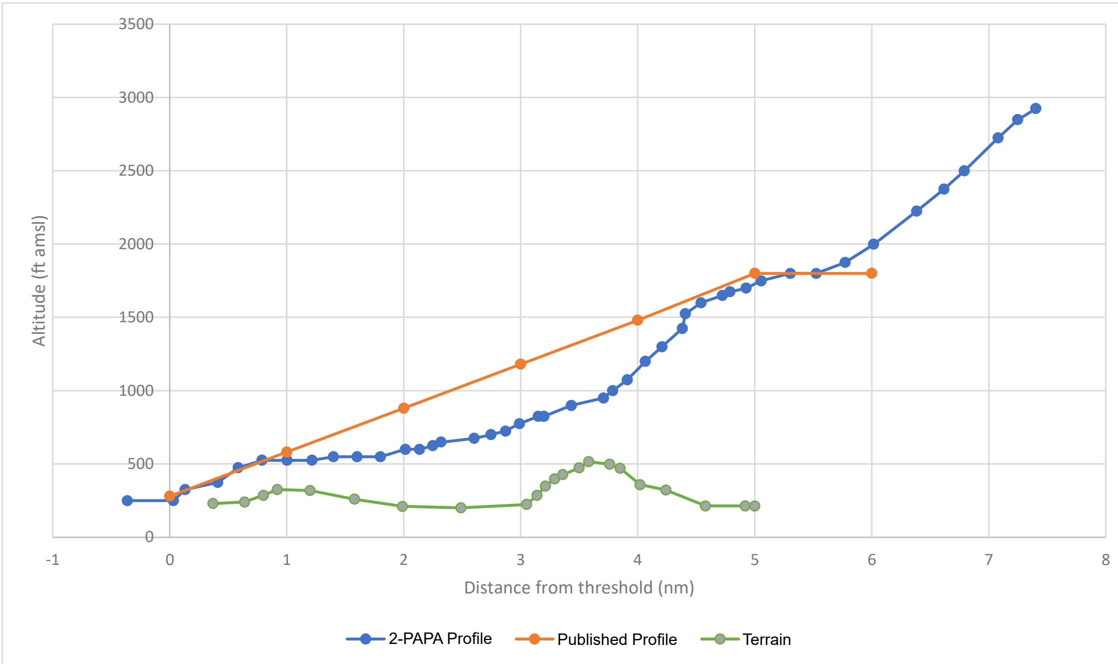


Figure 1

Profile flown by 2-PAPA compared to the published profile and terrain

Aircraft information

The NDB/DME approach to Runway 01 at Oxford was available in the aircraft's FMS database. The first waypoint in the database approach was coincident with the FAF and required the aircraft to be at 1,800 ft or above. The approach then prescribed a 3.0° descent profile to the runway threshold.

The approach could be flown by the autopilot by selecting NAV and VNAV prior to reaching the FAF. The altitude selector must be selected to an altitude below 1,800 ft to allow the aircraft to descend. The pilots were trained to reduce the selected altitude to zero or to the approach decision height to prevent the autopilot levelling prior to the runway.

It is not necessary to select 'vertical direct to' for the autopilot to fly the approach. Selecting vertical direct to a waypoint instructs the FMS to calculate a new vertical profile from the current altitude to the altitude specified at the waypoint selected and removes any existing profile.

In October 2020 the FMS manufacturer published a Service Information Letter (SIL) (revised in June 2021) advising operators of an anomaly that may result in an unexpected steeper descent while in FMS VNAV mode[3]. The SIL explains that after passing a waypoint the FMS updates its calculation to ensure it will meet the next constraint. If the next constraint is an 'at' or 'at or above' the FMS will include an adjustment to allow the aircraft to level off prior to the constraint. This adjustment can cause a temporary increase in the rate of descent.

It is possible that when the crew selected 'vertical direct to', triggering the FMS to recalculate the profile and removing the existing approach profile, that the anomaly described in the SIL caused the aircraft to start a steeper descent.

The approach can also be flown using the autopilot's heading and vertical speed modes.

Pilot information

Both pilots were qualified to fly the Challenger 601. The commander was a freelance pilot and had completed an operator proficiency check in March 2022. The co-pilot was employed by the operator and had completed proficiency checks and line training with the operator. They had both completed the operator's initial crew resource management training.

The commander's background was primarily in corporate aviation whereas the co-pilot's background was mostly in airline operations.

Both pilots reported feeling well rested prior to the flight but after the incident considered that fatigue may have been a factor. The day prior to the incident they had flown the aircraft from the Bahamas to Bristol. They both reported having slept well that evening. The next morning they flew the aircraft from Bristol to Guernsey but then had a four hour wait before flying to Oxford.

They both reported that they had not effectively briefed for the approach to Oxford. The co-pilot remembered some discussion about the approach prior to departure from Guernsey. The commander reported that the shortened routing meant he did not have time to brief the approach. The pilots had not agreed how they intended to fly the approach.

Operator information

The operator's Operations Manual (OM) contains several statements relevant to the approach.

GPWS

The crew response to a GPWS alert or warning was specified in OM A 8.3.5.3:

> *'The immediate action on receiving an alert will vary according to the stage of flight and aeroplane configuration, but must involve correcting the condition for which the alert was valid. No attempts should be made to recover the original flight path until the cause of the alert have been positively established and eliminated.*

Footnote

[3] Honeywell Service Information Letter – D202010001347.

Whenever a warning is received, however, the immediate response must be to level the wings and initiate a maximum gradient climb to the MSA [4] *for the sector being flown, except as in para 8.3.5.4.'*

Paragraph 8.3.5.4 specified that a warning may be treated as an alert when in day VMC conditions and it is immediately obvious to the commander that the aircraft is in no danger.

Stable approach criteria

OM B 2.13.1.1 specified the operator's stable approach criteria. It stated:

'An approach is considered to be stable when all the following are met:

- All briefings and checklists have been actioned.
- The aircraft is on the correct flight path.
- The aircraft is in the planned landing configuration.
- Power setting appropriate for aircraft configuration.
- The IAS is not more than final approach speed +10 kt and not less than V_{REF}.'

The manual stated that these criteria should be met when the aircraft is 1,000 ft above the approach decision height. The operator's minimum decision height for the NDB/DME approach was 740 ft so these criteria should have been achieved by 1,740 ft amsl. However, the manual stated that the approach could be continued if the commander was sure the criteria would be met by 500 ft above the approach decision height (1,240 ft amsl for this approach). The manual stated that a go-around must be flown if this was not achieved.

The section also stated that:

'Throughout the approach phase, descent rates should be no more than 1000 ft/min and vary by no more than +/- 300 ft/min. […] *If these conditions are not met, an immediate go-around must be flown.'*

Analysis

There was insufficient data for the investigation to determine with certainty why the aircraft entered a high rate of descent during the approach. A possible explanation is that, when the crew selected a vertical direct to the runway, the FMS deleted the existing vertical profile and calculated a new profile. By the time the FMS had calculated the new profile the aircraft was above the new profile so the autopilot commanded a descent to intercept the profile. It is also possible that an anomaly in the FMS (described in a SIL published by the FMS manufacturer) may have caused the high rate of descent when the FMS recalculated the profile.

Footnote

4 MSA – Minimum Safe Altitude.

Both pilots reported that they had not effectively briefed for the approach to Oxford, and that they had not agreed how they intended to fly it. It may have been possible to avoid the high rate of descent if the crew had discussed how they intended to fly the approach and had a shared mental model. The section of CAA CAP 737[5] on sharing information and mental models states:

> *'In multi-crew aircraft, sharing of information is vital, particularly for the effectiveness of the monitoring task. The same situation can look quite different to two people, depending upon their intentions and awareness of what the other knows. Monitoring pilots are handicapped if they do not have a full picture of what the flying pilot is intending to do.'*

According to the operator's OM the GPWS warning in IMC conditions required an immediate maximum gradient climb to MSA. The unstable approach and the rate of descent above 1,000 fpm required a go-around.

The co-pilot reported that he tried several times to tell the commander to go around but the commander decided to continue the approach. The commander did not recall the co-pilot telling him to go around. It is possible that an element of fatigue contributed to the communication difficulties. The section of CAP 737 regarding intervention and assertiveness states:

> *'Occasionally, even with direct and assertive comment* […], *the verbal intervention may fail. This can be for a number of reasons, but the most likely ones are that the other pilot's workload is high or situational awareness is poor, or a very poor crew relationship exists. These situations would be particularly difficult if the intervention was from the first officer to the captain.'*

Conclusion

A high rate of descent was established on final approach leading to a GPWS warning. The commander elected to continue the approach and landing despite several instructions in the operator's OM requiring a maximum gradient climb or go-around in these circumstances. The pilots' recollections differ on the verbal intervention offered by the co-pilot. It is possible that fatigue and miscommunication were contributory factors.

Footnote

5 CAA CAP 737 '*Flight-crew human factors handbook*', available at https://publicapps.caa.co.uk/docs/33/CAP%20737%20DEC16.pdf [accessed June 2022].

ACCIDENT

Aircraft Type and Registration:	DH89A Rapide, G-AIYR
No & Type of Engines:	2 De Havilland Gipsy Queen 3 piston engines
Year of Manufacture:	1943 (Serial no: 6676)
Date & Time (UTC):	19 June 2022 at 0930 hrs
Location:	Duxford Airfield, Cambridgeshire
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 8
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to underside of cockpit and front fuselage, both propellers and both engine cowlings
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	2,501 hours (of which 65 were on type) Last 90 days - 34 hours on type Last 28 days - 16 hours on type
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On landing the aircraft decelerated rapidly and unexpectedly. It pitched onto its nose and exited the runway to the right. The pilot and passengers were assisted out of the aircraft by the RFFS and all were uninjured. It was later discovered that the right main landing gear tyre had deflated either in flight or on touchdown.

History of the flight

The aircraft was conducting short, commercial passenger flights during the Duxford Airshow. The first sortie of the day had been completed without any abnormal events. On the second sortie the takeoff and planned local flying were conducted without incident. On returning to Duxford Airfield the pilot reported on the downwind leg to the Duxford Flight Information Service Officer and was advised to make a further report on final approach. He recalled completing the pre-landing checklist during which he physically confirmed that the aircraft wheel brakes were set to OFF. The aircraft was approaching Runway 06 at Duxford and the wind was reported as 340° at 10 kt. Therefore, there was a significant crosswind from the left, although it was within the aircraft limit of 20 kt.

The pilot recalled the aircraft touching down on the left main landing gear and then, as the right landing gear touched down, he felt a strong deceleration and the aircraft rapidly pitched nose down. He described the landing as a "not particularly heavy touchdown though with a bit of a skip". The tips of both propellors struck the runway followed by the underside of the aircraft nose. The aircraft slid with its nose touching the ground and gradually veered to the right. The aircraft departed the paved surface to the right and stopped on the grass with the nose on the ground (Figure 1).

Figure 1
Aircraft on nose post runway exit

Both engines had stopped but the pilot recalled securing the aircraft by turning off the magnetos, the fuel cocks, the radio and the battery master switch. He then confirmed that all the passengers were uninjured and directed the passenger in the rear left seat to open the cabin door. Due to the attitude of the aircraft the door was a significant distance above the ground.

The pilot could see no signs of fire and there was no smell of fuel. He saw a fire vehicle approaching the aircraft. Due to the distance of the door from the ground the pilot directed the passengers to remain on board until the RFFS could position a ladder to facilitate safe exit from the aircraft. The RFFS sprayed firefighting foam onto both engines and the surrounding ground and assisted all those aboard to evacuate the aircraft. Neither the pilot nor any passengers were injured.

Aircraft information

The aircraft is a DeHavilland Dragon Rapide built in 1943. It is registered as G-AIYR but is painted in historical Royal Air Force colours. It has a CAA Display of Registration Mark Exemption to allow the aircraft to be flown with the historic military serial number HG691.

Aircraft examination

After exiting the aircraft, the pilot noted that the right main landing gear tyre was completely deflated. The aircraft sustained damage to the underside of the cockpit and nose cone, to both propellors and to both engine cowlings.

The aircraft was examined by the operator's engineering personnel. It was jacked and the right wheel was found free to turn and was not loose on the axle. There was no visible damage to the landing gear or brake assembly. The creep marks[1] on the tyre were displaced by between one and two inches. The tyre was removed from the hub for further examination and a tear was found in the inner tube valve where it had been displaced from the wheel. There were two further small puncture marks in the inner tube. The tyre was undamaged.

Analysis

The aircraft landed with a crosswind of approximately 10 kt from the left. The pilot used into-wind aileron to control the drift, so the aircraft made an initial touchdown on the left main landing gear and then rolled right to touch down the right main gear. After the right main gear touched down, the aircraft decelerated rapidly and pitched onto its nose and then yawed to the right. This outcome is consistent with the expected effects of landing with a deflated right main tyre, as found after the event.

On the previous sortie of the day the pilot had not noticed any unusual effects during taxi, takeoff or landing. The taxi and takeoff for the incident flight were also completely normal. It is therefore likely that the right main landing gear tyre deflated in flight or on touchdown. It was not possible to determine when the creep on the right wheel occurred, but the damage to the inner tube was consistent with creep and so that was the probable cause of the deflation.

Conclusion

Due to the deflated right main landing gear tyre the aircraft decelerated rapidly and pitched onto its nose. The aircraft yawed to the right and exited the paved surface coming to rest on the adjacent grass. The aircraft suffered significant damage but none of those aboard were injured.

Footnote

[1] To detect the gradual rotation of a tyre around a wheel white index marks are made on tyres and wheels and are called creep marks.

SERIOUS INCIDENT

Aircraft Type and Registration:	ERJ 170-100 LR, G-CIXW
No & Type of Engines:	2 General Electric Co CF34-8E5A1 turbofan engines
Year of Manufacture:	2008 (Serial no: 17000230)
Date & Time (UTC):	7 June 2021 at 1150 hrs
Location:	Descent to Birmingham Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 5 Passengers - 18
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	4,050 hours (of which 83 were on type) Last 90 days - 20 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and information provided by the operator

Synopsis

The pilots were alerted to a pitch trim failure and associated autopilot failure which resulted in greater nose-down control forces in pitch, requiring the pilot to use more force to control the aircraft than was normal for an approach. With both hands on the yoke, the PF flew a stable approach and made a safe landing. On landing, the pilots were alerted to a fault in the steering system. No injuries or damage were reported.

The pitch trim fault was probably caused by the jamming of the actuator ball nut due to the freezing of water that had entered the component, itself probably the result of condensation. The steering system fault was due to a sensor failure unrelated to the pitch trim fault.

History of the flight

G-CIXW was flying from Gibraltar to Birmingham Airport. The pilots began the descent into Birmingham from FL380 and during the descent, about 90 nm from landing, an amber PITCH TRIM FAIL caution illuminated on the Engine Indication and Crew Alerting System (EICAS). On seeing the message, the PF disconnected the autopilot (AP) to counter the potential threat from a pitch trim runaway. Shortly thereafter, the AP FAIL caution illuminated, indicating the loss of the AP.

The pilots continued the descent into Birmingham and actioned the checklist in the quick reference handbook (QRH) for PITCH TRIM FAIL. They determined, both from the forces required to maintain the flight path and the trim indication, that neither the primary nor secondary trim systems were functioning and, as a consequence, nor was the AP.

The pilots did not declare an emergency and continued the descent as ATC vectored the aircraft for the ILS approach to Runway 15 at Birmingham. On the final approach, the PF found that he required more effort than usual to control the pitch of the aircraft. To counter this, the pilots decided that the PF would have both hands on the yoke to maintain control of the aircraft's flight path, while the PM would guard the throttle (since autothrottle remained engaged).

On landing, a STEER FAIL caution illuminated, together with a FLT CTRL NO DISPATCH caution. The commander, who had been operating as PM and occupied the left seat, took control and stopped the aircraft on the runway. The pilots then completed the STEER FAIL checklist in the QRH. The commander taxied the aircraft off the runway and onto the stand using differential braking and asymmetric power in accordance with the relevant abnormal checklist. On shutdown the commander advised the operator's maintenance control that the failures resulted in control issues both in the air and on the ground and made relevant entries into the aircraft technical log.

Aircraft examination

The operator carried out a maintenance inspection and the faults were rectified. This involved the replacement of the horizontal stabiliser actuator control electronics unit (HS-ACE), followed by an operational test on the horizontal stabiliser (HSTAB).

A sensor on the nosewheel steering system was found to be defective and replaced.

Recorded information

The event was notified nine days after it happened and consequently no CVR recording was available to the investigation. Relevant flight data is shown in Figure 1.

Prior to the descent from FL380 the AP was engaged, the pitch trim was recorded at -2.4° (nose up) and control column inputs were small. The descent was initiated with the AP in vertical path mode. Increasing amounts of control column pitch down input were recorded with no change in pitch trim until a jump in the recorded value passing through FL307 from -2.4° to 0°. Approximately 23 seconds later, the master caution was triggered. Approximately 24 seconds after that the AP was disengaged and remained disengaged for the rest of the flight. AP system failure was recorded about 15 seconds after it was disengaged, briefly at first and then continuously except for two short periods of 5 to 10 seconds. These two periods were when the recorded pitch trim position values switched from 0° to -2.4°, the AP system failure parameter became inactive, and co-pilot trim commands were recorded. After this the pitch trim position returned to 0°, the AP system failure parameter re-activated, and a master caution was triggered.

Pitch trim positions recorded during other flights were between approximately -4.7° and -7.4° during the final approach and landing phases. This would give more pitch up trim than the last reasonable value recorded on the incident flight of -2.4° of pitch trim. It is likely that this -2.4° of pitch trim reflected the actual pitch trim of the HSTAB during the approach and landing as this was the last value recorded before the parameter switched to reading an unreasonable value of 0° and there was no recorded trim activity after that. Less than normal pitch up trim is also indicated by greater than the normal pitch up control inputs required by the pilot.

Flight data monitoring programme (FDM) data indicated that the aircraft was speed stable and remained within 0.6 dots of the glideslope on the final approach for the ILS.

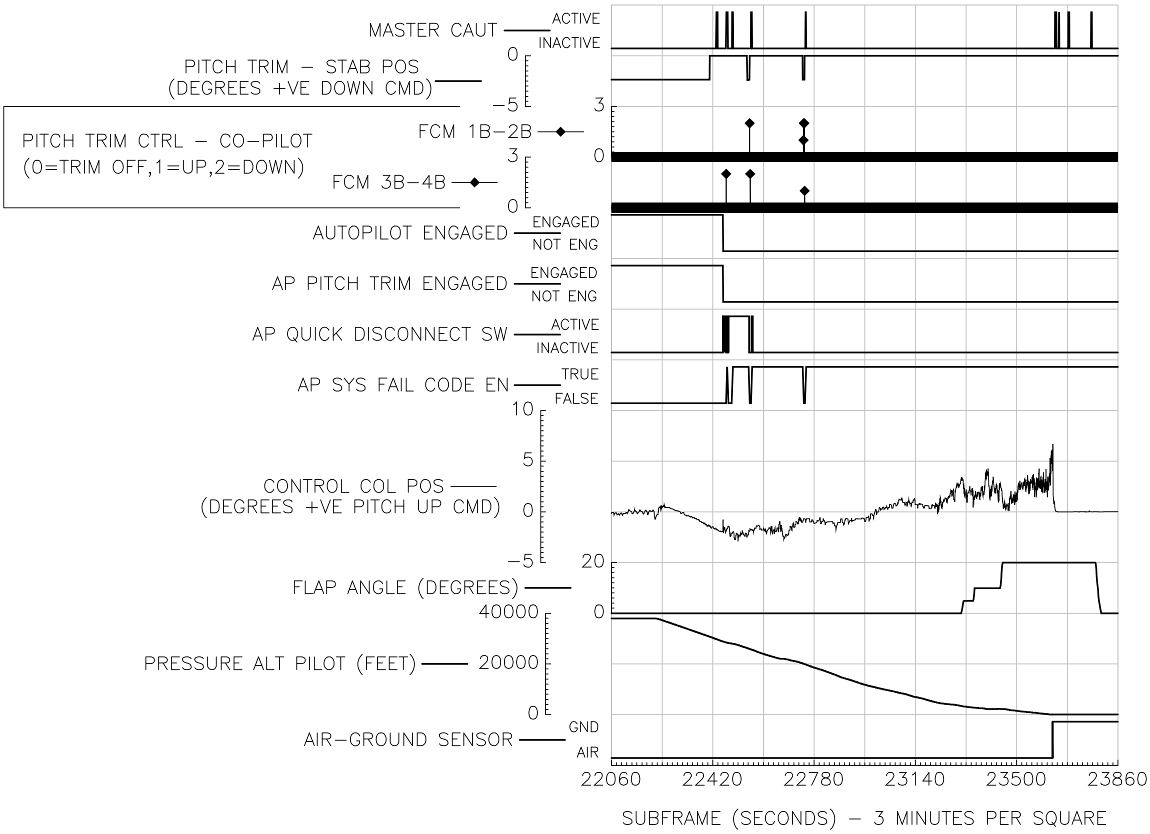


Figure 1

Pertinent extracts from the flight data recording

Aircraft information

Pitch control system

The aircraft has an electronic fly-by-wire system designed to operate the conventional control Surfaces. The horizontal tail surface consists of the HSTAB and the elevators. Pitch control is achieved by means of electro-hydraulically commanded elevators and an electro-mechanical HSTAB. Control is by autotrim, using the AP through the flight control module, or through manual trim, by either the captain's or first officer's main trim switches or the back-up trim switches, to the HS-ACE. If the AP trim function becomes inoperative, the AP will disengage and cannot be re-engaged without maintenance action.

The HS-ACE is a dual-channel active-standby redundant system, with each channel on receiving a signal, directly controlling its respective HS trim actuator (HSTA) servomotor to move a ball nut assembly linked to the HSTAB surface; this signal is also used for monitoring and EICAS indication.

In the event the active channel fails, the standby channel becomes active and both automatic and manual trim remain available. Following the failure of a single HS-ACE channel, the FLT CTRL NO DISPATCH caution will illuminate on landing. Following a failure condition that affects both HS-ACE channels, a PITCH TRIM FAIL caution will illuminate.

Nosewheel steering system

The aircraft nose landing gear has a steer-by-wire control powered by the No 2 hydraulic system and electronically controlled by the Nosewheel Steering Control Module.

The nosewheel steering has three modes of operation: handwheel steering mode, rudder pedal steering mode, and freewheel steering mode. The freewheel steering mode is mostly used for towing or when the normal steering system fails. In free wheel mode, steering can be accomplished using rudder, differential brake and/or asymmetrical thrust. The free wheel mode is automatically selected when:

- failure of the Air/Ground signal occurs, or
- nosewheel angle is greater than 76°, or
- nosewheel steering system failure is detected.

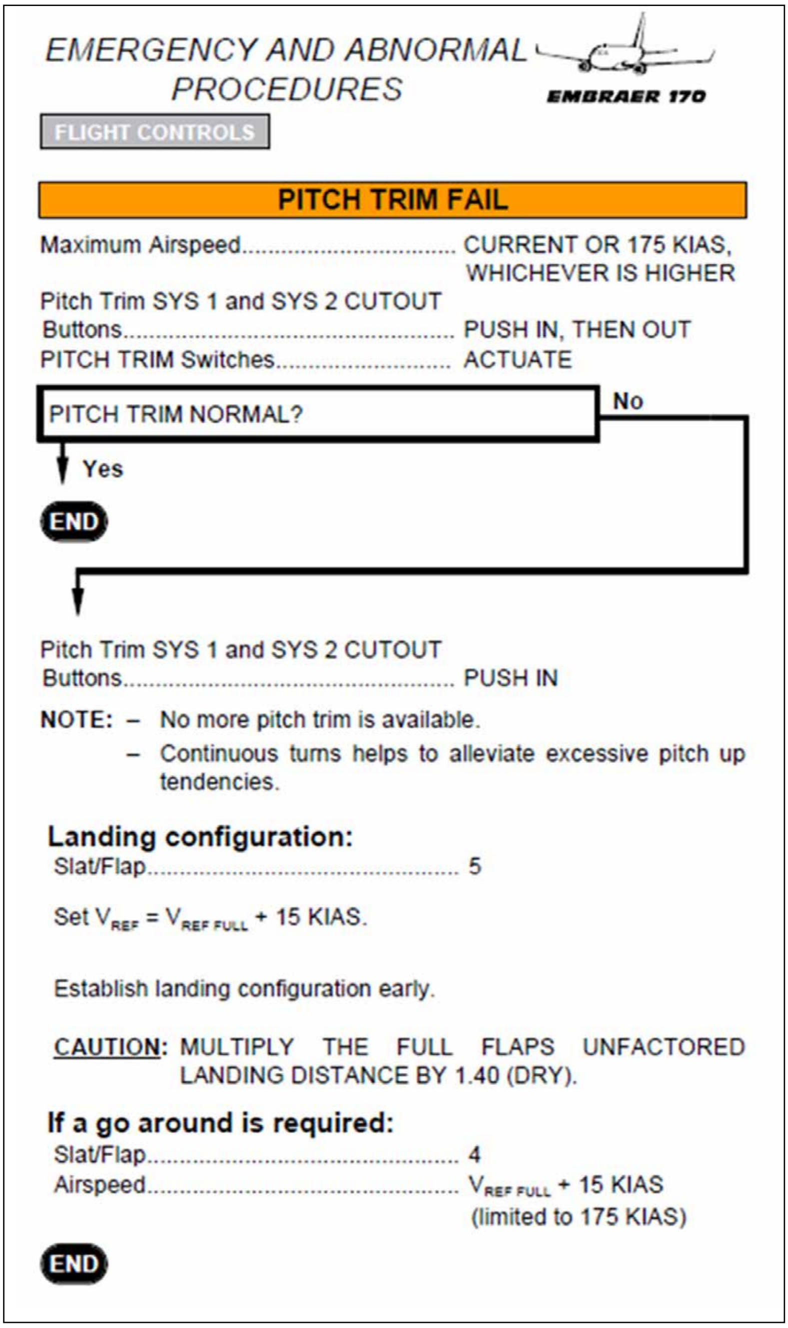
Crew Alerting System

The Crew Alerting System (CAS) is part of the EICAS and provides pilots awareness of the degradation or failure of aircraft systems by either a warning, caution, advisory or status message. Each CAS message has an associated emergency or abnormal procedure to manage the threats that arise from the system degradation or failure. The following messages, with their associated QRH procedures relevant to the incident were displayed:

- PITCH TRIM FAIL caution (Figure 2)
- STEER FAIL caution (Figure 3)

The FLT CTRL NO DISPATCH caution does not have an associated QRH procedure but is identified as a "Crew Awareness" caution. If a "Crew Awareness" message is displayed on the EICAS, takeoff is prohibited unless at least one of the following conditions is met:

- The message is an expected result of an intentional operation.
- Flight crew action is taken to clear the message.
- Maintenance personnel take action to clear the message.
- The aircraft is dispatched in accordance with all approved company minimum equipment list provisions.



EMERGENCY AND ABNORMAL PROCEDURES

EMBRAER 170

FLIGHT CONTROLS

PITCH TRIM FAIL

Maximum Airspeed................................ CURRENT OR 175 KIAS, WHICHEVER IS HIGHER

Pitch Trim SYS 1 and SYS 2 CUTOUT Buttons.. PUSH IN, THEN OUT

PITCH TRIM Switches.......................... ACTUATE

PITCH TRIM NORMAL?

Yes

END

No

Pitch Trim SYS 1 and SYS 2 CUTOUT Buttons.. PUSH IN

NOTE: – No more pitch trim is available.

– Continuous turns helps to alleviate excessive pitch up tendencies.

Landing configuration:

Slat/Flap... 5

Set $V_{REF} = V_{REF\ FULL} + 15$ KIAS.

Establish landing configuration early.

CAUTION: MULTIPLY THE FULL FLAPS UNFACTORED LANDING DISTANCE BY 1.40 (DRY).

If a go around is required:

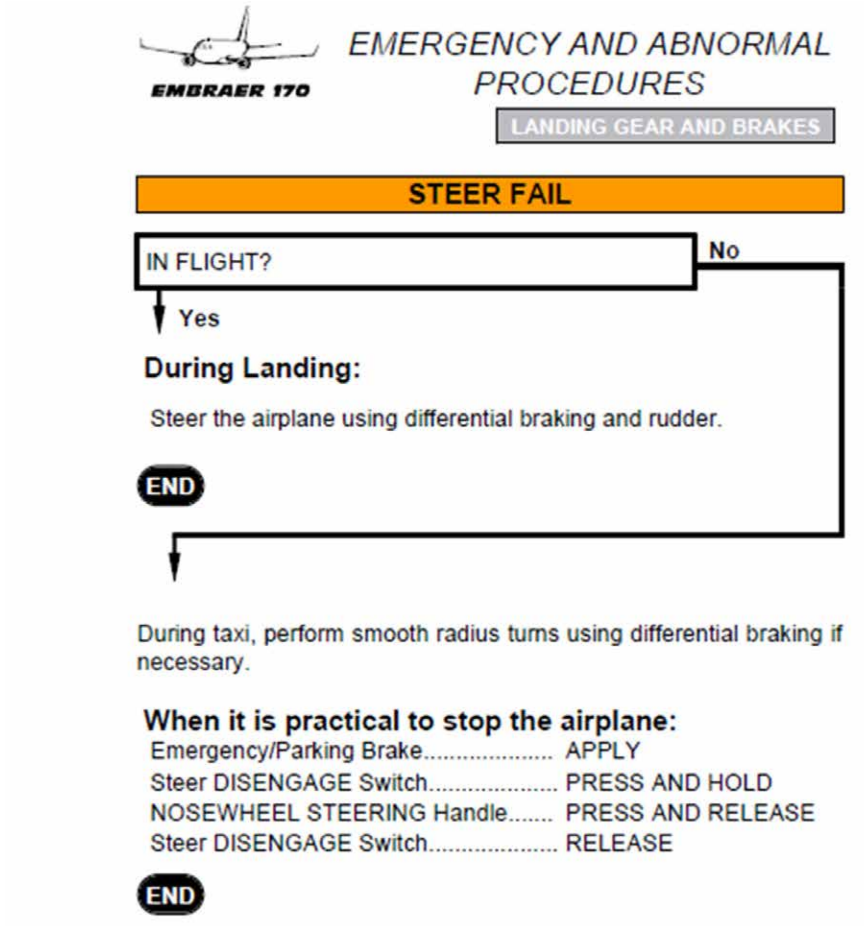
Slat/Flap... 4

Airspeed... $V_{REF\ FULL}$ + 15 KIAS (limited to 175 KIAS)

END

Figure 2

QRH Drill EAP8-6 – PITCH TRIM FAIL caution


EMBRAER 170

EMERGENCY AND ABNORMAL PROCEDURES

LANDING GEAR AND BRAKES

STEER FAIL

IN FLIGHT?

No

Yes

During Landing:

Steer the airplane using differential braking and rudder.

END

During taxi, perform smooth radius turns using differential braking if necessary.

When it is practical to stop the airplane:

Emergency/Parking Brake.................... APPLY

Steer DISENGAGE Switch.................... PRESS AND HOLD

NOSEWHEEL STEERING Handle....... PRESS AND RELEASE

Steer DISENGAGE Switch.................... RELEASE

END

Figure 3

QRH Drill EAP 13-5 – STEER FAIL caution

Tests and research

Manufacturer analysis

The fault history database (FHDB) was recovered from the aircraft and supplied to the aircraft manufacture for decode and review. In its response it stated:

> *'Analysis of the recorded flight data showed that the "PITCH TRIM FAIL" occurred in the early stage of the descent, and the FHDB data suggests that this symptom is possibly related to a degraded performance of the horizontal stabilizer mechanism.'*

And:

> *'The presence of pitch trim fail displayed in flight is caused by a failure condition, affecting both HS-ACE channels …described by the Service Newsletter (SNL) 170-27-0067 issued on Aug/2018, where the HSTA jam condition was found as a root cause for the field events of pitch trim fail. …water ingression in the*

ball nut due to condensation phenomena was considered most likely to be the root cause for jamming in cold temperatures and long flights. In this case fully greasing the ball nut assembly reduces the amount of water that could ingress minimizing the probability of jamming and the message pitch trim fail.'

In response to similar occurrences, in June 2009, the manufacturer had previously reduced the interval between horizontal stabiliser actuator lubrications from 1,500 to 1,000 flight hours. It demonstrated that this had significantly reduced the number of such cases, with no pitch trim fail events related to HSTA jams in the previous 12 months as of August 2020.

The manufacturer also commented that:

'During troubleshooting on ground, the effects of the low temperature disappear, which may induce operators to misdiagnose the root cause and replace the HS-ACE.'

The manufacturer observed that *'due to Covid pandemic, this aircraft has been parked for some time recently'* and stated that *'the effectiveness of lubrication may also be affected by a prolonged parking period';* consequently, *'lubrication of the HSTAB is part of the return-to-service activities for prolonged parking.'*

The aircraft manufacturer recommended removal of the HSTA for further testing.

Operator investigation

The operator conducted its own investigation into the incident reviewing FDM data for the flight and speaking with the crew. It deduced that the two short periods when the recorded pitch trim stab position values switched from 0° to -2.4° and the AP system failure parameter became inactive, were a result of actuation of the pitch trim switches by the crew when they carried out the PITCH TRIM FAIL QRH procedure.

The PF stated to the operator that the aircraft had a slight nose-down tendency which required larger than normal input to achieve the desired nose attitude for the approach, and which was described as 'fairly benign'.

From a review of FDM data the operator identified no FDM events for stabilisation criteria. It further assessed that the data did not show any significant control difficulties or significant differences in lateral G for comparable flights during the approach and on landing. The operator concluded that the event was well-managed by the crew. It made no recommendations for crew actions or performance.

The technical element of the investigation reported that:

'The [HS-ACE] *unit had been inspected on a recent input at our chosen MRO* [maintenance provider]. *No defects had been noted during the inspection.'*

The strip report of the unit, following the event, identified a failure of the No 1 channel.

The operator established that the HSTA had been lubricated 313 flight hours before the event. The aircraft maintenance manual defines a period of prolonged parking as '*Short out of operation time 8-60 days*.' A review of the aircraft's flight utilisation over the 5 months prior to the event established that there were only two occasions (both in March), where it was not utilised for extended periods beyond 8 days (10 and 11 days respectively). On average the aircraft was out of operation for 3.5 consecutive days in the same period, with average utilisation of 2.25 consecutive days. The operator confirmed that the aircraft maintenance manual did not require lubrication of the HSTAB in those circumstances.

Having identified the HS-ACE as the faulty unit, and replaced it, the operator did not remove and inspect the HSTA following the incident.

Since the event, the operator has reported no repeat of the defect. It concluded the pitch trim fail was the result of failure of HS-ACE, while the STEER FAIL caution was unrelated and the result of a sensor failure. The AP failure was a direct consequence of the pitch trim failure.

Analysis

The fixed position of the horizontal stabiliser was probably caused by the jamming of the ball nut due to the freezing of water ingress, itself probably the result of condensation. Although examination of the HS-ACE only identified a single channel failure, this condition alone should not prevent the surface movement as the channels are automatically switched after the failure of one channel. (The system is designed so that only one HS-ACE channel is active at a time and is able to command the system). Since the HSTAB was fixed, the active channel was not able to command any movement. After switching, the standby channel became active but could not command movement as well for the same reason. This condition resulted in the loss of pitch trim functionality and illumination of the PITCH TRIM FAIL caution.

The disengagement of the AP by the PF, even though this is not required by the relevant procedure, addressed the hazard of a more potentially serious trim condition of a pitch trim runaway. AP trim functionality, indicated by the illumination of the AP FAIL caution, would not have been available owing to the pitch trim failure.

Failure probably resulted in the HSTAB being stuck at -2.4°, (and that the two occasions, where -2.4° was recorded, were the result of the crew completing the actions which required the de-selection and re-selection of the pitch trim cut-out switches as part of the pitch trim failure procedure.) The consequence of the stabiliser being stuck was that the PF experienced heavier nose-down forces in pitch than would be normal, requiring stronger than normal pilot inputs to maintain the correct pitch attitude for the approach. The decision by the pilots that the PM would monitor the throttles, which were in autothrottle, to enable the PF to place both hands on the yoke to control pitch attitude, gave the PF the control to make the required pitch changes. The approach subsequently flown was stable and resulted in a safe landing.

The investigation found that the operator had lubricated the HSTAB in accordance with the recommended intervals, which were intended to prevent such an occurrence, as specified by the manufacturer.

The STEER FAIL caution was triggered by a sensor failure. This resulted in the loss of steering through the pedals (and the handwheel) which required the PF to steer the aircraft in free wheel mode using differential braking.

The PITCH TRIM FAIL and STEER FAIL cautions were unrelated. The nature of the failures, affecting control both in the air and the ground, together with the FLT CTRL NO DISPATCH CAS message required further action by the operator before the aircraft could be declared serviceable, necessitating an entry in the aircraft technical log by the commander.

Conclusion

The failure of the pitch trim system probably occurred because of jamming of the horizontal stabiliser as a result of freezing of water ingression in the ball nut due to condensation. The investigation found that the operator had lubricated the horizontal stabiliser at the intervals specified by the manufacturer to prevent such an occurrence.

Jamming of the horizontal stabiliser resulted in the loss of the pitch trim functionality. Consequently, the PF experienced greater than normal nose-down pitch forces on the approach. The PF delegated the monitoring of the throttles, which were still in autothrottle, to the PM to allow him to use both hands on the yoke. The PF flew a stable approach and made a safe landing. However, on landing, the STEER FAIL caution illuminated, as a result of an unrelated sensor failure. The commander took control and brought the aircraft to a safe stop and taxied the aircraft to stand using differential braking.

SERIOUS INCIDENT

Aircraft Type and Registration:	Saab 340B, G-NFLB
No & Type of Engines:	2 General Electric Co CT7-9B turboprop engines
Year of Manufacture:	1998 (Serial no: 340B-456)
Date & Time (UTC):	14 September 2021 at 1125 hrs
Location:	6 nm east of the Isle of Islay, Argyll and Bute
Type of Flight:	Training
Persons on Board:	Crew - 4 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Failed Generator
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	14,894 hours (of which 7,208 were on type) Last 90 days - 92 hours Last 28 days - 25 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent enquiries made by the AAIB

Synopsis

Following the intentional shutdown of the left engine for training purposes, the crew were unsuccessful in re-starting the left engine, owing to a failure of the right engine starter/generator. This resulted in the aircraft being in a one engine inoperative state on battery power only. The crew made a VOR approach to Campbeltown and landed safely about 40 minutes after the failure of the generator.

History of the flight

The crew departed Glasgow airport on G-NFLB for a training flight as part of a programme to convert crews to the type, which had recently been introduced into the fleet of the operator. The crew for the flight consisted of four persons:

- The commander was contracted by the operator to provide his services as a type rating examiner qualified to deliver training on the SAAB 340 aircraft and simulator; this enabled him to conduct engine shutdown and re-lights on the aircraft. The commander's primary employment was with another operator that operated in Scotland and had SAAB 340 aircraft in its fleet. The commander operated in the right seat for the flight and was delivering training on the handling characteristics of the aircraft.

- The trainee was a commander and nominated person with the operator. He was converting to type and operated in the left seat as pilot in command under supervision.
- The observer in the jump seat, was the operator's programme manager for the introduction into service of the SAAB 340. He had previously held training qualifications for the aircraft type.
- A further crew member, contracted to provide his services to the operator as a TRI and line trainer, was in the cabin, having completed his training earlier in the flight and subsequently swapped seats with the incident trainee.

The flight profile was intended to cover aircraft handling characteristics including stalling as well as an intentional in-flight engine shutdown and restart. This was to enable the trainee to experience the one engine inoperative (OEI) handling characteristics of the aircraft. (Experience from another operator indicated that the simulator exhibited more severe OEI handling characteristics than the actual aircraft.) The pre-flight briefing considered the threats and typical scenarios, such as failure to re-light an engine.

At FL120 in VMC, following completion of other demonstrations and exercises, the commander initiated a scenario involving a drop in oil pressure in the left engine, resulting in the shutdown of an engine in-flight. The commander then demonstrated OEI aircraft handling. For the engine re-light in-flight, the commander was PF, and the trainee was PM.

Prior to the re-light, the commander discussed the possibilities in the event of a start malfunction, including the vital actions. The commander then initiated a manual start for the left engine, which drew on the right engine generator. Engine speed was seen to stagnate at 40% N_g before dropping, resulting in an unsuccessful re-light.

A few seconds later, as the crew were discussing the hung start, the electronic flight instrument system (EFIS) screens went blank. The commander handed control to the trainee and the crew conducted a diagnosis, identifying that the right engine generator had failed. They performed relevant vital actions and carried out the emergency procedure for generator reset, but without success. The crew now recognised that the aircraft was flying on one engine only and electrically powered only by the batteries. Consequently, in addition to the loss of the flight instruments, among other systems lost, the Flight Management Computer (FMC) was also lost. At this point, in view of the aircraft state, the trainer in the cabin made a note of the time. He continued to monitor the time and advise the commander as appropriate throughout the rest of the flight.

The commander recognised that the key threat was time remaining to the exhaustion of battery power. He delegated the completion of the emergency procedure for the *Loss of Both Generators (Both Engines Running)* and the load-shed of non-essential electrical equipment to the observer. Meanwhile, he declared a MAYDAY and requested the weather for Glasgow, Prestwick, Islay and Campbeltown Airports.

The trainee, now as PF, focused on flying the aircraft, with only the standby instruments available, and descended the aircraft to FL100 in VMC in the area between the Mull of Kintyre and Islay. While there was a layer of cloud over the water below, the crew could see that the cloud was more widespread over the land; though they were able to see the southern end of the Mull of Kintyre through it.

The crew reviewed the situation using the decision analysis tool TDODAR[1] and considered a re-light of the left engine using battery power. However, they recognised that, after load shedding, the batteries would provide only 60 minutes power from full charge; they were concerned by how much battery power would be consumed in attempting a re-light, with the hazard that the re-light might not be successful. Consequently, they decided not to attempt a re-light. However, the crew decided to tie the battery busses together, even though this was not a stated action in the emergency procedure.

On reviewing the weather, the crew recognised that they would need to fly an instrument approach to be able to safely descend below minimum sector altitude (MSA) and make an approach to an airport. They recognised that the remaining aircraft systems only allowed a VOR or ILS approach to be flown by tuning the relevant frequency on NAV box 1 and the display of the Standby Omni Bearing Selector (OBS). The loss of the FMC removed the option to make a GNSS approach. The Radio Magnetic Indicator (RMI) and ADF were also not available.

The commander identified that while Prestwick only had an NDB approach available and was consequently not an option, Glasgow offered a VOR and ILS approach. While the weather at Glasgow was deteriorating with the cloud base likely precluding the availability of a VOR approach, the ILS remained possible. However, the commander discounted the option of making an approach to Glasgow owing to the time constraints resulting from the aircraft being powered only by the batteries. The weather at Islay and Campbeltown was more favourable, and these airports were visible through the cloud layers, but they only offered an GNSS approach. However, the commander had the Electronic Flight Bag (EFB) of his primary operator to hand; this included a VOR approach for Campbeltown which was approved for use by his primary operator. Consequently, the decision was made by the crew to make an approach to land at Campbeltown using the VOR approach.

The PM requested a radar vector for Campbeltown, and the PF descended the aircraft to MSA at which height the crew had sight of the surface through breaks in the cloud. The PF intercepted the final approach track for the VOR procedure and saw the runway at about 6 nm. The aircraft landed safely about 40 minutes after the right engine generator failed.

Footnote

1 TDODAR is a decision-making tool, often used in emergency situations to help structure the decision-making progress. The mnemonic stands for Time, Diagnose, Options, Decide, Act or Assign, Review.

Aircraft information

The Saab 340B is a regional aircraft powered by two General Electric CT7-9B turboprop engines. It can be configured to hold up to 36 seats, but in its role as a flying classroom, G-NFLB was configured with 33 seats.

There are four main electrical systems on the aircraft:

- a 28 V DC system, powered either from two engine driven generators, from two batteries or from an external power source.
- an emergency power system, powered from the ordinary DC system or from an emergency battery.
- a frequency-controlled AC system, powered from the DC system through a main or standby inverter.
- a "wild" frequency system used for ice protection only.

The two engine driven generators also serve as engine starters. These starter generators are controlled by separate generator control units (GCUs) which control the DC system and protect it against faults in the generation system. The GCUs also control the engine start cycle and disengage the starter at 55% N_g.

An external power receptacle on the right aft fuselage wing fairing (Figure 1) allows a ground power unit (GPU) to be connected to the aircraft. Under normal circumstances engine starts are carried out with the GPU connected, as it has been found that repeated battery starts can damage the batteries and reduce their service life. When using external power to start the engines the left engine is normally started first. Once the engine is stabilised the GPU is disconnected, and the right engine can be started using cross fed power generated from the left engine. Starting the right engine first would create a hazard for the ground operations staff when disconnecting the GPU in the propeller wash from the engine.

During an in-flight engine start the opposing engine's generator, in combination with aircraft batteries, will provide the electrical power to start the engine. Although an engine start can be conducted from the main batteries alone, it can significantly deplete their stored energy and reduce their endurance. The aircraft operating manual does not state the amount of battery charge a single engine start will consume.

If both generators go offline, the emergency checklist procedures E5-1 to E5-3 specify immediate load reduction[2]. Without it, the endurance of the main batteries is less than 15 minutes; it is approximately 45 minutes if the load reduction is carried out within five minutes. If additional load reduction[3] is carried out, the checklist states that the endurance

Footnote

[2] Immediate load reduction includes, switching off both recirculation fans, the left and right avionics switches, the inverters, the emergency lights, the hydraulic pump and pulling the circuit breakers for the utility bus, all external lights and some internal lights.

[3] Additional load reduction includes, switching off engine ice protection, windshield heating, standby pitot heating, the windshield wiper, propeller and wing de-icing, the flood lights and the passenger address system.

can be extended to '*a minimum of 60 minutes*'. This leaves only essential equipment connected to the hot[4] battery bus, essential busses and emergency busses available to the crew.

Figure 1
External power connection rear of right wing

G-NFLB had recently been acquired by the operator, having been in long term storage for the previous nine years. At the time of the incident the aircraft had a valid certificate of airworthiness, and the airworthiness review certificate was in date. The aircraft had flown approximately 31 hours since it was owned by the operator.

Aircraft examination

The starter/generator, which had accrued 261 hours since its last overhaul, was removed from the right engine and sent to a component repair organisation for investigation. The examination revealed that the generator armature had two raised bars (Figure 2) and damage to the brushes. This resulted in arcing and subsequent failure to generate current.

The maintenance organisation suggested that the most likely cause of the damage was repeated starts with insufficient cooling time between them. It identified this is a known failure mode attributed to current being applied to the stationary armature during the start sequence, which heats it and results in the commutator bar lifting.

Footnote

[4] The hot battery busses are electrical busses powered directly from the battery and power systems, such as the engine fire extinguishers, cargo fire extinguishers, attitude and heading reference system back-up power and battery controllers.

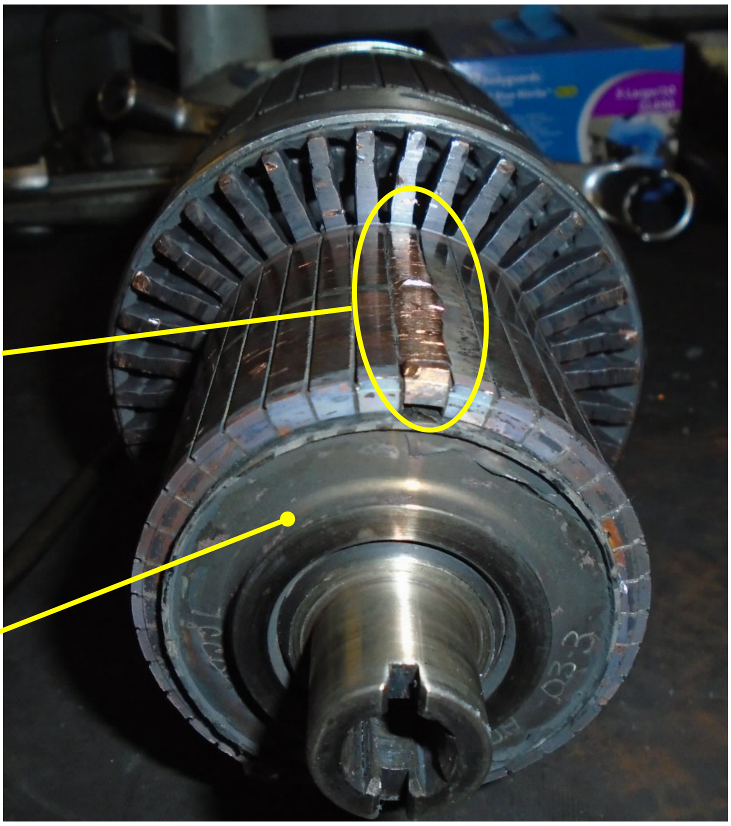


Figure 2

Starter Generator Armature showing lifted raised and damaged bar on the commutator

During the 31 hours of operation by the operator, there had been no repeat starts carried out. It was therefore considered likely that if insufficient time between starts had been the cause of the issue, this occurred whilst the aircraft was operated by its previous owner, the damage remaining dormant until the generator was heavily loaded during the in-flight engine start of the opposite engine.

Meteorology

An aftercast provided by the Met Office for the morning of 14 September covering Glasgow and Prestwick, and the area to the west stated:

> *There were outbreaks of rain, drizzle and occasional showers, with heavy rain or showers at times. There were multiple layers of cloud: stratus with bases from 400-1200FT and tops of 1500FT away from sea fog, and bases on the surface in sea fog. Further thick layers of cloud with bases 1500-4500ft and tops 7000-12000FT away from fronts and the trough…. Away from fronts and the trough there would have been gaps between stratocumulus and altocumulus layers, but close to fronts and the trough cloud would likely have been thick. Visibility was generally good, dropping to moderate in rain or showers, and poor in sea fog.*

There was an occluded front running north-south to the west of the western isles. There was also a trough running approximately south-west to north-east, which is indicated by the rainfall seen on the radar picture (Figure 3).

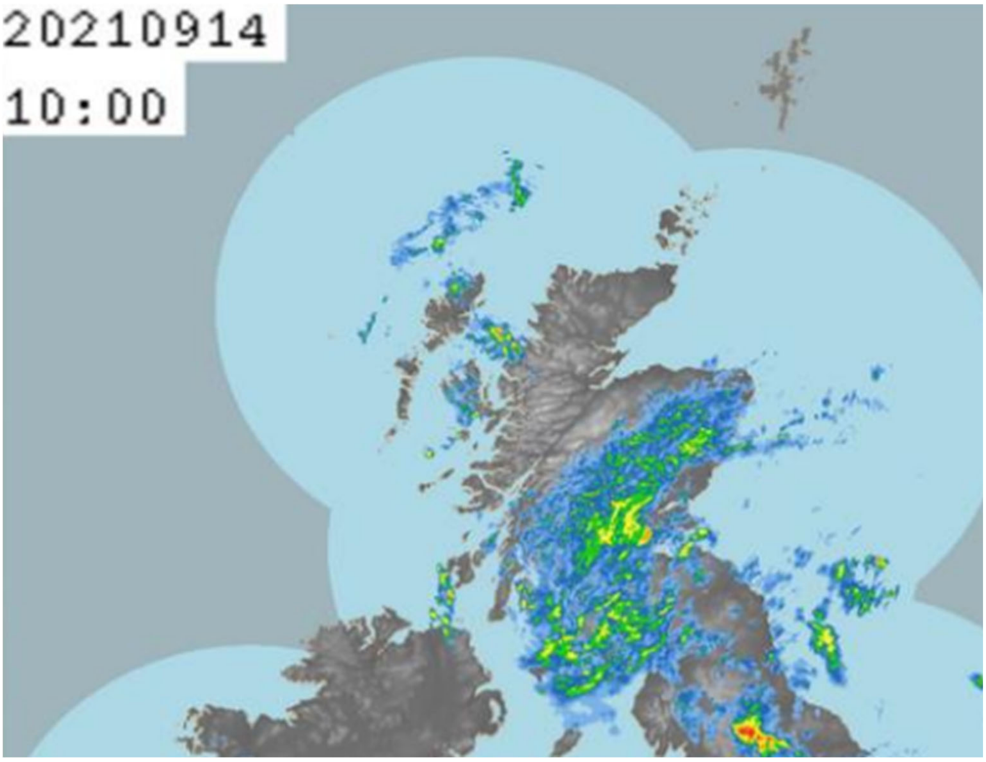


Figure 3

Radar picture of northern British Isles at around time of departure

Glasgow was forecast to have a cloud ceiling of 1,800 ft reducing to 1,000 ft temporarily, with 6 km visibility and a possibility of further reductions temporarily in the morning to 400 ft in 2 ½ km in rain and drizzle. Prestwick forecast a cloud ceiling of 3,000 ft. There would also be periods of the cloud ceiling temporarily reducing to 1,200 ft with 7 km visibility, and a possibility of further reductions temporarily in the morning to 600 ft in 3 km in rain and drizzle.

Meanwhile, the weather forecast for Campbeltown indicated a cloud base of 700 ft and cloud ceiling of 1,600 ft, though there was a probability that the cloud ceiling would reduce to 400 ft in 4 km visibility. The forecast weather for Islay was similar.

At the time of the incident, Glasgow had a cloud ceiling of 700 ft in light rain while Campbeltown had a cloud base of 900 ft and cloud ceiling at 2,100 ft in good visibility; Islay was similar.

Aerodrome information

Glasgow Airport

Glasgow has a single runway aligned 05/23 which provides for ILS, NDB, VOR and Surveillance Radar (SRA) approaches. The minima for the SRA approaches were higher than the actual weather while the VOR approach gave a minima of 484 ft aal.

Prestwick Airport

The main runway for Prestwick is 12/30 to which there are GNSS, ILS, and NDB approaches available. The secondary runway, 03/21, offers NDB DME or GNSS approaches. There is also an SRA approach to Runways 12/30 and 21.

At the time of the incident the main runway was unavailable due to resurfacing.

Campbeltown Airport

The AIP for Campbeltown specifies only GNSS approaches, even though the airport retains the VOR/DME and NDB radio navigation aids. The primary operator of the commander, which operates in this area, has an operator approved VOR approach for Campbeltown (Figure 4). This can be accessed through the primary operator's EFB which is maintained on a tablet.

Organisational information

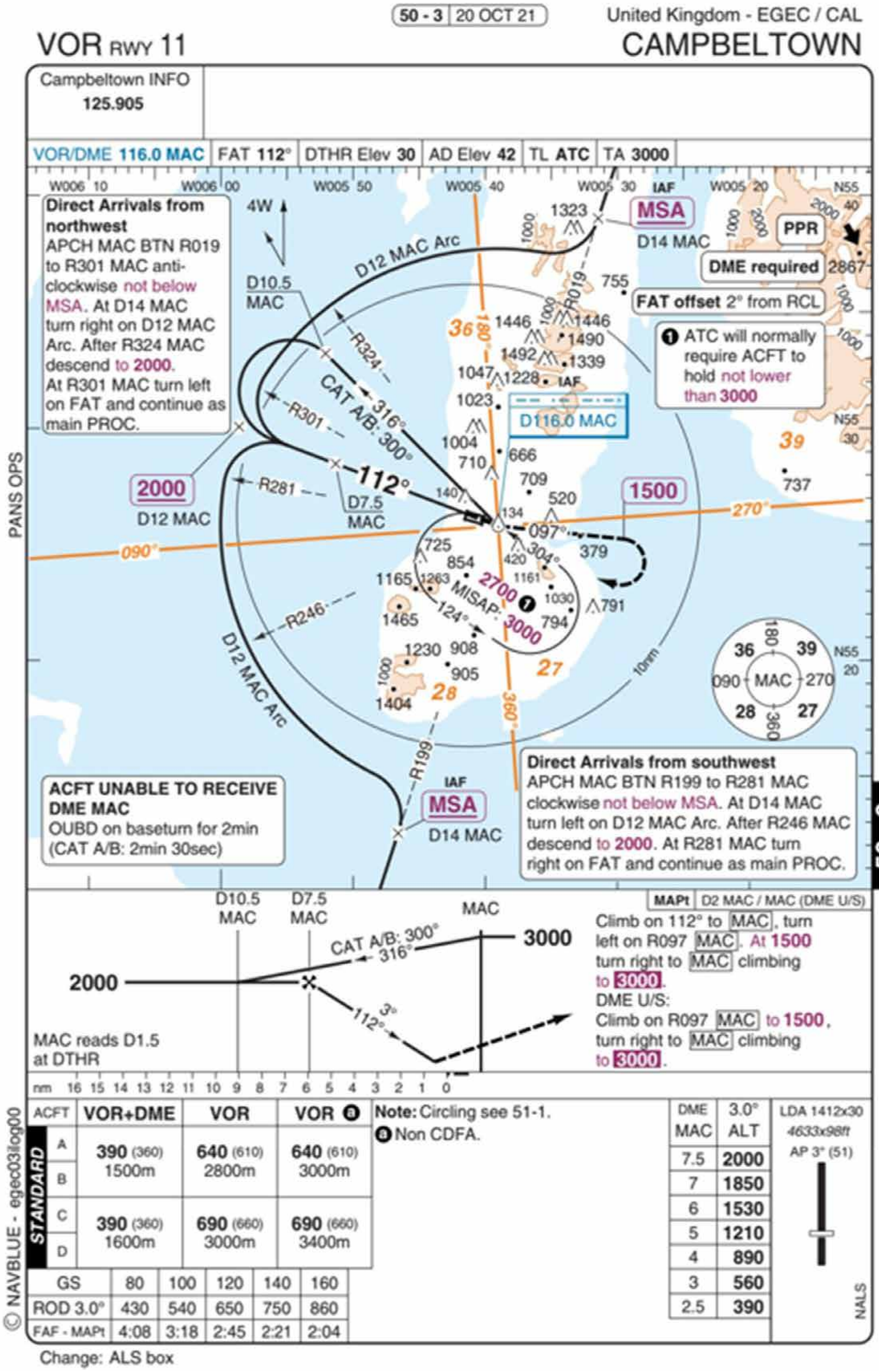
Operator

The operator operates G-NFLB as a flying classroom and engineering laboratory used to support teaching, research, and consultancy. The aircraft is fully instrumented to provide passengers and students with real-time data on a range of performance parameters. The flight profiles also include:

- flight trials of customers' experimental equipment.
- flight testing technologies associated with unmanned air vehicles.
- flight clearance testing of aircraft modified for special roles.
- measurement and analysis of an aircraft's characteristics for use in future airborne equipment.

As part of this operational remit, there is a requirement at times to intentionally shut down an engine to demonstrate the aircraft's performance in an OEI state.

The operator was in the process of introducing the SAAB 340B into its fleet and conducting conversion training for its crews when the incident occurred.



ACFT		VOR+DME	VOR	VOR
STANDARD	A, B	390 (360) 1500m	640 (610) 2800m	640 (610) 3000m
STANDARD	C, D	390 (360) 1600m	690 (660) 3000m	690 (660) 3400m

GS	80	100	120	140	160
ROD 3.0°	430	540	650	750	860
FAF - MAPt	4:08	3:18	2:45	2:21	2:04

DME MAC	3.0° ALT
7.5	2000
7	1850
6	1530
5	1210
4	890
3	560
2.5	390

Figure 4

Plate for approach to Campbeltown

Other information

The GEN busses are connected automatically by the closing of the bus tie relay, thereby connecting the batteries when the aircraft is on battery power only (Figure 5). The bus tie relay is open when both generators are operating, but close following the loss of a single generator.

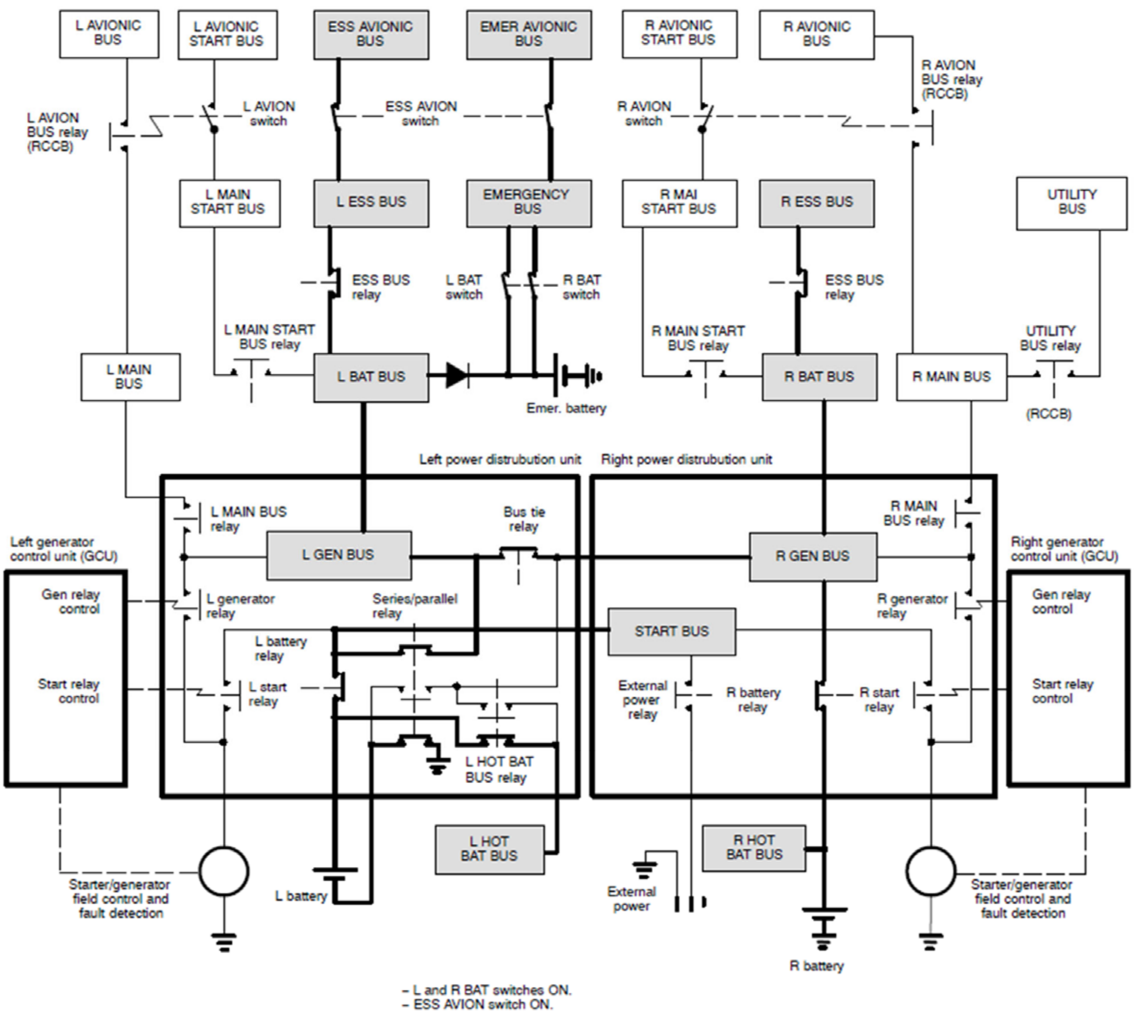


Figure 5

Electrical system showing busses (shaded) powered by battery power only

The emergency procedure in the aircrew flight manual (AFM) for the loss of both generators with both engines running states:

> *'The immediate actions for loss of both generators is to set the Bus tie to* SPLIT *and try to reset one generator at a time (Maximum two reset attempts per generator). If the generators cannot be reset, set them off and reduce electrical load.'*

This is reflected in the procedure, on pages E5-1 to E5-3 of the emergency checklist, entitled '*Loss of Both generators (Both Engines Running)*'. The checklist does not specify connecting the batteries in parallel by setting the bus tie to CONN[ect] in the event neither generator can be reset.

There is no procedure in the emergency checklist or the AFM for the loss of both generators when in an OEI configuration.

Analysis

Following the unsuccessful re-light of the left engine and the failure of the right generator, the aircraft was operating on one engine and on battery power only.

The situation was the result of a considered decision to conduct an in-flight shut down of the left engine in-flight for training purposes and the latent damage to the generator of the live engine. The shutdown was not required as part of the training for conversion to the aircraft type but was conducted to demonstrate the single engine handling qualities of the aircraft, which the simulator was not thought to represent accurately. It also stemmed in part from the prospect that, owing to the nature of the operation, there would likely be occasions requiring an engine to be shut down in-flight.

An examination of the right engine starter/generator found that it had failed and could not provide any power to allow a cross start of the left engine. The failure of the generator was considered by the component overhaul organisation to be the result of multiple starts with insufficient time between them to allow the unit to cool. The operator reported that there were no starts of this nature during the time that aircraft had been operated by them. It is therefore likely that, if the cause of the generator failure was insufficient cooling between successive starts, these starts occurred whilst the aircraft was operated by the previous owner. The damage sustained by the generator then became apparent when operated under high load during engine start.

During routine operation the left engine was always started first using the GPU. The right engine was then started using electrical power from the generator on the left engine. The left engine's generator is routinely loaded to provide power to start the right engine. Conversely, the right engine's generator usually only provides power for the right electrical system and is normally lightly loaded. Only when it was highly loaded during the attempted in-flight re-light of the left engine did the generator fail. As the location of the aircraft GPU receptacle does not allow for starting on the right engine first, the right generator had not previously been sufficiently highly loaded to induce failure. Had the right engine been used to cross start the left engine whilst on the ground, the generator failure may have occurred earlier, resulting in the inability to start the left engine but doing so in a safe environment.

The use of TDODAR as a decision-making tool in an emergency situation aided the crew to consider the relevant issues in a structured manner and resulted in effective management of the situation.

The crew recognised that time, because of limited battery life, was a crucial resource to manage. The trainer in the cabin immediately took on the role to note and monitor the time, ensuring this important element was not overlooked. The commander was able to delegate the urgent requirement to load-shed the electrical system in order to maintain battery endurance, while he spoke with ATC and gathered information on the weather at the nearby airfields. This enabled the PF to focus on flying the aircraft without undue distraction. The number, experience and composition of the crew aided the commander to manage a high workload and time critical situation.

The emergency procedure for the loss of both generators considered this scenario with both engines running, and not in the OEI configuration. However, system knowledge enabled the crew to act appropriately and ensure effective load shedding of non-essential equipment was carried out in a timely manner, preserving battery power. System knowledge also assisted the crew to make the decision to re-tie the batteries together, even though this was not required by the procedure. Connecting the batteries in parallel ensured that the available battery life would be shared by the systems on each side.

Faced with the need to descend below MSA safely and only the means to make a VOR approach, it was fortuitous that the commander had the EFB of his primary operator to hand which had a plate for a VOR approach to Campbeltown. Although this was an approach only approved for use by the commander's primary operator, the situation with which the crew were faced was an emergency.

Conclusion

The engine was shutdown intentionally as part of a training exercise. The right starter/generator had latent damage probably caused by insufficient time between starts in service with a previous operator. The right starter/generator then failed under loads higher than those it was normally subjected to, which had not occurred previously because it was not normally used for engine starts. The crew of four, who all had relevant experience, coordinated their activities to produce a successful outcome, and were assisted by the availability of a non-precision approach procedure approved for use by another operator for whom one of them also flew.

ACCIDENT

Aircraft Type and Registration:	Europa XS, G-REJP
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2007 (Serial no: PFA 247-14086)
Date & Time (UTC):	25 November 2021 at 1305 hrs
Location:	Nuthampstead Airfield, Hertfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Fractured fuselage, damaged propeller and main wings twisted on spar
Commander's Licence:	Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	1,413 hours (of which 5 were on type) Last 90 days - 19 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

A significant left yawing tendency during the aircraft's takeoff roll resulted in the pilot rotating the aircraft early to avoid a lateral runway excursion, probably causing the wing to stall. The aircraft than struck a raised earth bank.

The report considers rule-based takeoff decision making, rejected takeoff considerations, and methods for self-briefing those items before departure.

History of the flight

The pilot reported that after applying full power to depart from Nuthampstead Airfield's grass Runway 05, the aircraft yawed left "slightly more than usual". He countered it with right rudder and brake, expecting rudder would compensate for the yaw as airspeed increased. However, later in the takeoff roll, even with full right rudder and right brake applied, the aircraft began departing left of the runway surface (Figure 1).

The pilot described reaching a "critical point" whereby to avoid damage related to a runway excursion, and with the aircraft "nearing its takeoff speed", he stopped applying right brake and rotated the aircraft into the air. It became airborne briefly but touched down adjacent to the runway and struck a raised earth bank.

Airfield information

Pilots describe Nuthampstead's runway as *'well-maintained'* but *'known to get waterlogged after several days rain'.*

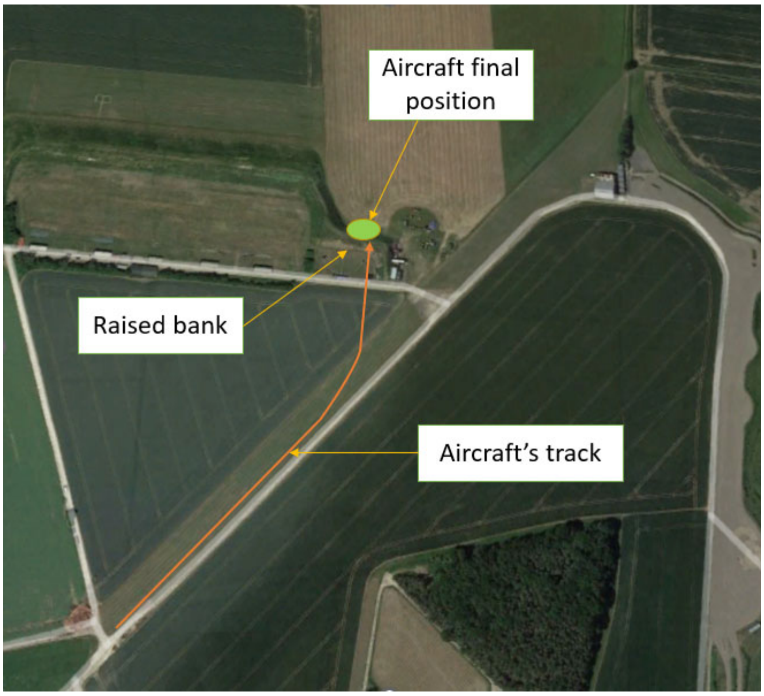


Figure 1
Approximate track for accident takeoff

Meteorology

Information from the pilot and weather reports from three adjacent aerodromes indicated that the wind at Nuthampstead at the time of the accident was from 340° at 10-11 kt.

Reports from those aerodromes showed intermittent periods of fog and mist, and drizzle and light rain, during the six days prior to the accident. Temperatures mainly varied between 2° and 7°.

Aircraft information

The Europa XS Trigear is a two seat homebuilt aircraft, with fixed main and nose landing gear. Its maximum gross weight is 621 kg.

The *'Europa XS Trigear Owners Manual'*[1] described the *'normal take off procedure'* as follows.

> *'Open throttle smoothly and keep the aircraft tracking straight with rudder pedals (be prepared to apply right rudder to counter blade effect).*

Footnote

[1] Issue 6, July 2012

> *The take off run should be commenced with the stick slightly aft of neutral to reduce the load on the nose wheel. Once elevator control has been achieved, which will be at about 30 - 35 kts, the nose can be raised slightly followed by a positive rotation at 50 kts…'*

The *'Cross wind take off'* section stated:

> *'The Europa has quite a small, round, rear fuselage, a fairly small fin, and a powerful rudder.*
>
> *The demonstrated cross wind component of the aircraft is 15 kts. With the Rotax engine fitted, which turns the propeller clockwise as viewed from the cockpit, the effect of engine torque, the rotating prop wash and gyroscopic precession of the propeller makes a cross wind from the port side the worst case*[2]*. If the wind is at 90° to the runway, take off with the wind from the right.*
>
> *Be prepared to use substantial differential braking to keep the aircraft straight in the early part of the takeoff run.*
>
> *Practice your cross wind takeoffs and landings on a wide runway and* ***gradually*** *build up your experience.*
>
> *Europas have been operated in cross winds greater than 20 kts but pilot skill and experience is very important. Find the cross wind limit that you are comfortable with and stick to it.'*

The *'Short or rough field take off'* section stated:

> *'…Do not try to fly the aircraft off the ground before flying speed has been reached. On a rough field where the aircraft is being thrown into the air by undulating ground, resist the temptation to over rotate. This will simply stall the main wing, create increased drag and slow down or even stop the acceleration. By trying to force the aircraft off the ground too early the takeoff distance can easily be doubled and in the worst case extended indefinitely.'*[3]

The investigation did not determine if there was a pre-existing technical fault with G-REJP.

Information from the pilot

Additional information relating to the accident flight

The pilot reported he did not consider rejecting the takeoff. He rotated the aircraft and lifted off at 45 KIAS. He observed that G-REJP's airspeed indicator was of a different style than he was used to, which he found difficult to read as the aircraft accelerated on the runway.

Footnote

2 For a propeller rotating clockwise as viewed from behind, 'prop wash' and gyroscopic precession cause left yaw, and engine torque increases the effective load on the left main landing gear. A port cross wind creates a yawing moment left, into wind.

3 The text in this paragraph was already italicised in the original document.

The pilot stated that while inspecting the aircraft the following day he found no apparent obstruction in the rudder system. Muddy tyre tracks on the runway indicated the left main wheel had "not been rolling properly". He wondered if the left brake had been binding, but the subsequent damage prevented a determination.

He recalled the grass runway surface being damp but firm.

Relevant experience

The pilot stated he had owned the aircraft for around a month. Most of his flying experience was on a Mooney M20J[4], including operating from grass runways. He had completed 20 takeoffs and landings in G-REJP, including circuits at Nuthampstead on 23 November. He performed some of those flights with an LAA instructor.

The pilot had held a PPL since 1988 and could not recall receiving any training relating to takeoff decision making, rejected takeoffs (RTOs), or briefing[5,6] those prior to departure. He said he habitually self-briefed before departure his intended actions for an engine failure after takeoff and, for instrument departures, his planned departure route.

Takeoff decision making

Regulatory information from the CAA

The CAA's guidance document *'Class, Type and Instrument Rating Skills Tests and Proficiency Checks…'* for single pilot aeroplanes[7] included the following information in *'Abnormal and Emergency Procedures'*:

> *'Rejected takeoff… Recognise a situation where the safest course of action is to reject the takeoff… Take appropriate actions to stop safely within the remaining runway; inform ATC… Consider and demonstrate/discuss appropriate actions following RTO (e.g. engine shut down, evacuation, precautions for hot brakes etc).'*

The corresponding CAA *'Examiners Report…'* form[8] specified that an assessment of a *'Rejected Takeoff at a reasonable speed'* was a mandatory element of the check.

The CAA's policy and guidance document on *'LAPL and PPL Skill Test (Aeroplanes)'*[9] stated:

> *'…the applicant will be required to perform a rejected take-off… Shortly after the applicant starts his take-off run, the examiner will announce some form of emergency…; the applicant will be expected to discontinue the take-off and*

Footnote

4 A 4-seat aircraft with a maximum weight (takeoff and landing) of 1243 kg.
5 Departure briefing – Carried out prior to takeoff, and can include pertinent threats, weather, planned departure, emergencies and takeoff decision making.
6 While briefings are often performed in multi-crew operations, they are useful for preparation and rehearsal in single pilot settings, even if they are not vocalised.
7 Standards Document 14 v7_Nov 2014.pdf [accessed 3 March 2022]
8 SRG1157.fm (caa.co.uk) [accessed 24 March 2022]
9 Standards Document 19(A) v9.pdf [accessed 24 March 2022]

bring the aeroplane smoothly to a halt using all of the remaining runway without harsh use of the brakes; any appropriate touch drills should be completed and any radio calls should be made 'in cockpit' to the examiner.'

The CAA's webpage on *'Single engine piston rating for aeroplanes'*[10] explained that, to revalidate the rating, a pilot must either pass a proficiency check or complete 12 hours of flight time in a relevant aircraft within specified time periods; the 12 hours of flight time to include a training flight of at least one hour[11] with a flight instructor.

The training flight is also referred to as 'refresher training'.

CAA guidance to flying training professionals

The CAA's 'TrainingCom Autumn 2019'12 newsletter contained guidance on 'Aeroplane Skill Tests and Proficiency Checks'13.

'Both Skill Tests (ST) and Proficiency Checks (PC) require the candidate to demonstrate a REJECTED TAKE-OFF (RTO). It is insufficient for the examiner conducting the test to just discuss this element. The examiner should include the RTO procedures in the pre-flight briefing and then during the flight the examiners should ideally scenario [sic] to introduce the RTO. The candidate should be allowed to demonstrate their practical skills in the detection, diagnosis and performance of the appropriate actions to the point of aircraft evacuation when appropriate.'

The *'TrainingCom Autumn 2019 update'*[14] included *'Suggestions for the content of refresher training'*. It stated:

'The average private pilot once qualified will probably only fly with an instructor during refresher flight training, therefore, the flight is a valuable opportunity to evaluate common points of weakness as well as including exercises that the pilot may want to cover, with emphasis on good practice.'

The article listed *'Common points observed by instructors conducting check flights'*, including:

'The Threat and Error Management (TEM)[15] *concept is very rarely used, many PPL holders have not heard of, or do not understand, the concept…*

Lack of departure brief and passenger safety briefing.'

Footnote

10 Single engine piston rating for aeroplanes | Civil Aviation Authority (caa.co.uk) [accessed 10 March 2022]
11 Or specified equivalent.
12 The CAA's Training news update for flying training professionals.
13 TrainingCom_Nov2019_CAP1853_corr.pdf (caa.co.uk) [accessed 10 May 2022]
14 TrainingComUpdateAutumn2019(CAP1860).pdf (caa.co.uk) [accessed 23 March 2022]
15 TEM involves pilots thinking ahead to identify threats and specify ways to avoid or deal with potential errors associated with those threats.

Suggestions for related training included:

> *'Discuss with your pilot the use of threat and error management and get them involved. For example, ask them about any threats to their safety during their flight with you and how they can be mitigated, such as a wet grass runway or a crosswind…*
>
> *Use of the WANT mnemonic: Weather, Aircraft, NOTAM's and Threats…*
>
> *Do they give a take-off/eventualities brief? If not, discuss one suitable for them.'*

Safety Sense Leaflet

The CAA's *'Safety Sense Leaflet 7c Aeroplane Performance'*[16], Section 6 *'Takeoff - points to note'* stated:

> *'Decision point: you should work out the runway point at which you can stop the aeroplane in the event of engine or other malfunctions, e.g. low engine rpm, loss of ASI, lack of acceleration or dragging brakes. Do NOT mentally programme yourself in a GO-mode to the exclusion of all else. If the ground is soft or the grass is long and the aeroplane is still on the ground and not accelerating, stick to your decision-point and abandon take-off. If the grass is wet or damp, particularly if it is very short, you will need a lot more space to stop…'*

Interviews with PPL pilots, instructors, and examiners

During the investigation the AAIB interviewed PPL holders, PPL flight instructors (FI), flight instructor and examiners (FI/FE), and flight instructor examiners (FIE)[17] at different locations. These indicated that training and awareness of RTOs and related decision making was variable. Several long-term PPL holders said they could not recall initial RTO training, nor subsequent refresher training regarding RTOs. One FI/FE suggested that flight instructors may benefit from more knowledge in that area.

All the instructors interviewed indicated that pilots commonly focus on "getting into the air", rather than considering an RTO, when preparing for taking off.

One FI/FE said RTOs were one of the most commonly repeated test items, mainly to address decision making. Consequently, the associated pilot training organisation (PTO) had developed a structure for takeoff decision making: after applying takeoff power students would check that engine instruments and ASI were indicating normally, and that the aircraft was tracking the runway centreline. Thereafter they would make a 'stop or continue' takeoff decision. An FIE reported that pilots starting FI training commonly did not perform departure briefings. Therefore, their PTO produced an aide memoire for departure briefings, which included determining:

Footnote

[16] SafetySense Leaflet 07 (caa.co.uk) [accessed 9 February 2022]
[17] A 'Flight instructor and examiner' trains and examines student pilots, whereas a 'Flight instructor examiner' trains and examines those 'Flight instructors and examiners' for them to perform their role.

- takeoff runway
- wind information
- relevant airspeeds for takeoff and climb
- a 'stop or continue' decision point in the event of a problem
- actions in the event of stopping
- actions in the event of a minor or a major problem after becoming airborne
- departure information in the event of a normal takeoff

An FIE familiar with the Europa Trigear indicated it has challenging cross wind handling characteristics.

Other guidance

EHEST's training leaflet[18] relating to decision making for single pilots, suggested that the 'skill, rule and knowledge' model of information processing[19] can refer to the amount of conscious effort a person exerts in making a decision.

An academic paper on *'Understanding human behaviour and error'*[20] described those behaviours as follows:

- 'Skill' based behaviours are *'highly practiced'* and automatic in nature.
- 'Rule' based behaviours require more conscious effort. They are *'Pre-packaged units of behaviour'* which are *'released when* [the] *appropriate rule is applied'*. For example, *'IF the symptoms are X THEN the problem is Y… IF the problem is Y THEN do Z'.*
- 'Knowledge based behaviours are *'almost completely conscious'*. For example, when a *'beginner'* performs a task, or an expert experiences a *'novel situation'*.

Analysis

The accident takeoff

The combined effects of the propeller and crosswind, and any tendency of the left wheel to dig into the grass surface, would have produced a left yawing tendency requiring a counteracting right rudder input throughout the takeoff roll, and possibly some right brake in the early part of the takeoff roll.

The wet and cool weather conditions preceding the accident may have meant the grass was unexpectedly wet, affecting the aircraft's handling characteristics. If, as the pilot suggested, the left brake was binding, the left yawing tendency may have exceeded the available aerodynamic control.

Footnote

[18] en (europa.eu) [accessed 17 May 2022]
[19] Developed by Rasmussen (1979)
[20] The Skill, Rule and Knowledge Based Classification (humanreliability.com) [accessed 25 March 2022]

In order to prevent a runway excursion, the pilot rotated the aircraft before its takeoff speed had been reached, probably causing one or both of the wings to stall. He had not considered stopping.

Takeoff decision making, rejected takeoffs, and departure briefings

The pilot habitually considered his actions in the event of an engine failure after takeoff. However, like others consulted during the investigation, he had not recently considered the decision making aspect of the takeoff roll, or his intended actions for rejecting a takeoff. He could not recall any training he may have received in those areas.

Regulatory guidance and relevant academic works indicate a simple, rule-based structure for decision making is appropriate for the takeoff roll, during which decisions and resulting actions must be clear and prompt. Given that an abnormal event during takeoff would be novel for most pilots, a rule helps to avoid an unreliable automatic response, and reduces the conscious effort required by a more knowledge-based response.

Regarding the accident takeoff, the decision-making structure suggested by one FI/FE would indicate rejecting the takeoff if the aircraft was not tracking the runway centreline or if there were a lack of acceleration. Other indications that an RTO might be necessary would include using *'substantial differential braking to keep the aircraft straight'* beyond the *'early part of the takeoff run'.*

The likelihood of a successful outcome can be increased by using a briefing structure to rehearse rules and relevant responses; this might include actively considering the possibility of stopping as well as continuing the takeoff, and managing the hazard of wet grass or a crosswind.

Flight training

Although it is mandatory for examiners to assess RTOs, the investigation revealed that many PPL holders did not regularly consider takeoff decision making or their actions for an RTO. The attention given to those items during training appeared variable.

The CAA's TrainingCom publication indicates that refresher training presents an opportunity to brief and practice takeoff decision making, RTO techniques, and threat and error management.

As a result of this accident the CAA intends to produce an article in its *'Clued Up'* magazine about takeoff decision making and RTO considerations in general aviation; to include, for example, encouraging pilots to specify, before each takeoff, a runway decision point, and to consider the actions required to stop the aircraft. It has stated that it intends to explore other methods of promoting that guidance and new ways of engaging with the general aviation flight training community in this context.

Flying a new aircraft type

There was no evidence of a technical fault. The Europa is considered by some to have challenging handling characteristics in moderate crosswinds. This accident highlights the benefit of pilots reviewing the characteristics of a new aircraft type and identifying differences with those they've flown before, such as instrumentation and handling. It can be beneficial to apply more conservative operating limits, such as for crosswind component, while gaining experience on a new type.

Conclusion

To avoid a runway excursion the pilot rotated the aircraft before a safe flying speed had been reached, probably causing the wing to stall. The pilot described having been unable to overcome a left yawing tendency during the takeoff roll, the cause for which was not established.

Structured self-briefing before takeoff can assist clear decision making and prompt action in the event the takeoff does not proceed normally.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-181, G-BFSY
No & Type of Engines:	1 Lycoming O-360-A4M piston engine
Year of Manufacture:	1977 (Serial no: 28-7890200)
Date & Time (UTC):	25 June 2022 at 1740 hrs
Location:	Chatteris Airfield, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to left wing and nosewheel spat
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	33 years
Commander's Flying Experience:	1,800 hours (of which 130 were on type) Last 90 days - 90 hours Last 28 days - 35 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by AAIB

Synopsis

The aircraft landed on a disused section of runway at Chatteris Airfield, due to a combination of insufficient airfield detail available during flight planning, and disused runway markers obscured by long grass. Safety actions have been taken by the flight planning tool provider and local flying club to update the airfield information. The airfield has also taken action to maintain the grass length.

History of the flight

Upon reaching Chatteris the pilot overflew the airfield to assess landing conditions, then proceeded to make an approach onto what he believed to be Runway 24. On landing, the aircraft veered to the left on rough ground, resulting in a loss of directional control and came to rest in bushes at the side of the runway (Figure 1). The pilot later discovered he had landed on a disused section of runway 23, located at the threshold of Runway 24.

Aerodrome information

Chatteris Airfield is unlicenced and used for intensive parachute operations, requiring Prior Permission Required (PPR) from visiting pilots. The airfield has five grass runways varying in length from 405 to 810 metres. Runway 05/23 is 810m in length, with a disused section of approximately 290m at the north-eastern end marked with white crosses to make it visible from the air. Runway 06/24 intersects 05/23 at the point where the disused section begins.

The pilot reported that he did not see the white crosses during either overflight or approach, due to overgrown grass.

Figure 1
Accident site

Flight Planning

The pilot used an online flight planning tool providing basic airfield information, including an airfield plan (Figure 2) known as a 'plate'. The plate for Chatteris did not mark the disused section of Runway 05/23. More detailed airfield plates are available, via subscription, within the tool which the pilot had a subscription for. These showed the disused section marked with white crosses and contained a warning: however, on this occasion, this detailed airfield plate did not display when the pilot was planning the flight.

Visiting pilot information on the airfield's flying club's website shows an older airfield plate without disused runway markings, advising Runway 05/23 is under construction and to check availability. Whether PPR was obtained by the pilot is disputed between pilot and airfield.

Analysis

Flight planning and visual information available to the pilot was not sufficient to indicate that the section of runway landed on was disused, leading him to continue the approach. Flight planning tool software content is dependent upon data accuracy and balanced against its intended level of detail. Flight guides are regarded as a more detailed source of information to supplement planning software and PPR information.

The disused runway markers, acting as the last visual reference to the pilot, were obscured due to long grass, leading him to continue the approach despite overflying the airfield beforehand. Visibility of the crosses would have also identified Runway 23 from the closely-orientated Runway 24.

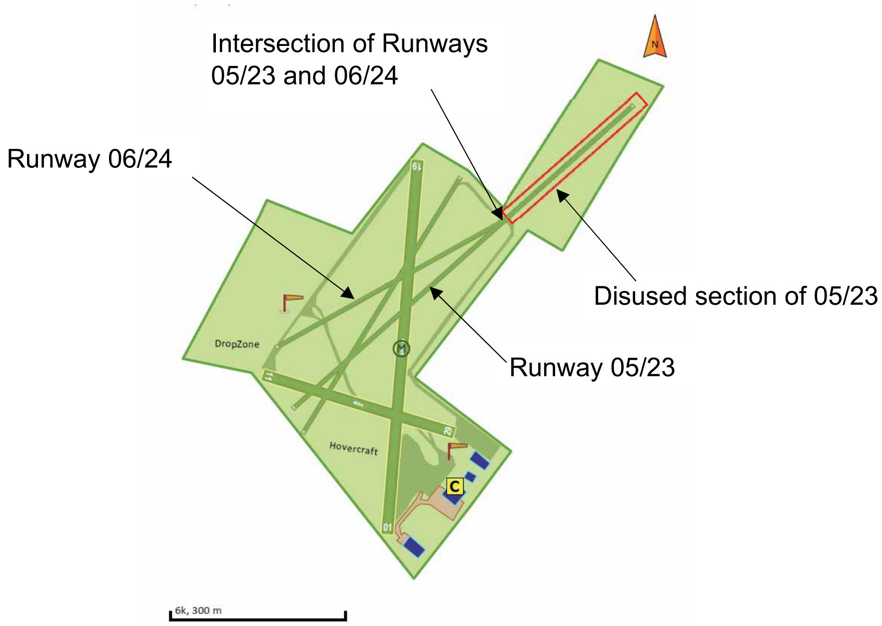


Figure 2
Example Chatteris Airfield plate

Conclusion

The pilot landed on a disused section of runway due to a combination of insufficient detail available during flight planning, and the disused runway markers being obscured by long grass.

The following safety actions have been taken:

- The airfield management team have taken action to cut the grass of the disused section of Runway 05/23 so that the white crosses are more visible.
- The flight planning tool provider have updated their airfield plate to show the disused section of Runway 05/23.
- The flying club's website is updating their visiting pilot information to display the latest airfield plate showing the disused section of Runway 05/23.

ACCIDENT

Aircraft Type and Registration:	Taylor Monoplane, G-BRUO
No & Type of Engines:	1 Volkswagen 1600 piston engine
Year of Manufacture:	1990 (Serial no: PFA 055-10859)
Date & Time (UTC):	21 June 2022 at 1130 hrs
Location:	Fishburn Airfield, County Durham
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Substantial damage to front fuselage and engine separated from aircraft
Commander's Licence:	Light Aircraft Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	981 hours (of which 9 were on type) Last 90 days - 6 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The accident happened during takeoff on Runway 26 at Fishburn Airfield with reported CAVOK weather conditions and a 5 kt northerly wind. The pilot reported "extremely poor" forward visibility so was referencing the side of the runway during the initial part of the takeoff. He applied full throttle and, once there was sufficient speed, the tail came up providing him with better visual cues. At this point, the pilot realised he was heading right of his intended direction and believes that he over-corrected in both directions. The final deviation was to the right when he became "just about airborne". He tried to fly out of the situation but had insufficient height and speed. He flew into the corn field to the north of the runway and stated that, as soon as the wheels touched the corn, the aircraft overturned and came to rest on top of him. The pilot sustained a fractured vertebra. In hindsight, he believes he should have closed the throttle and abandoned the takeoff earlier.

ACCIDENT

Aircraft Type and Registration:	EV-97 Teameurostar UK, G-CFNW
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2008 (Serial no: 3317)
Date & Time (UTC):	5 March 2022 at 1100 hrs
Location:	A6105, 1.5 Miles East of Duns, Scottish borders
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Damaged beyond economical repair
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	950 hours (of which 499 were on type) Last 90 days - 7 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After a precautionary field landing two days prior, G-CFNW was attempting to take off on a public road. The left wing struck a hedge at the side of the road causing the aircraft to turn through 180° and come to rest on top of the hedge. The pilot had not requested permission to use the road from the local council, nor had he informed the police of his intentions.

History of the flight

On 3 March 2022 the pilot was flying G-CFNW from Sherburn-in-Elmet Airfield in Yorkshire to Perth Airport in Scotland when he was confronted by deteriorating weather as he crossed the Scottish border. He descended to remain clear of cloud and, assessing that he would not be able to continue the flight under VFR, made a precautionary landing in the nearest suitable field just over 3 km to the east of Duns (Figure 1).

The pilot secured the aircraft and spoke with police who had been alerted to the landing by members of the public. He also informed the aircraft operator and landowner of the situation and of his intent to return to the aircraft on the following day to fly it out of the field. However, due to heavy rain and low cloud, the weather on the following day was unsuitable for a VFR flight. On Saturday 5 March 2022, the pilot flew back to the landing site, accompanied by another pilot, landing next to G-CFNW at around 1010 hrs. He found that the field had become saturated from the previous day's rain and was now very boggy.

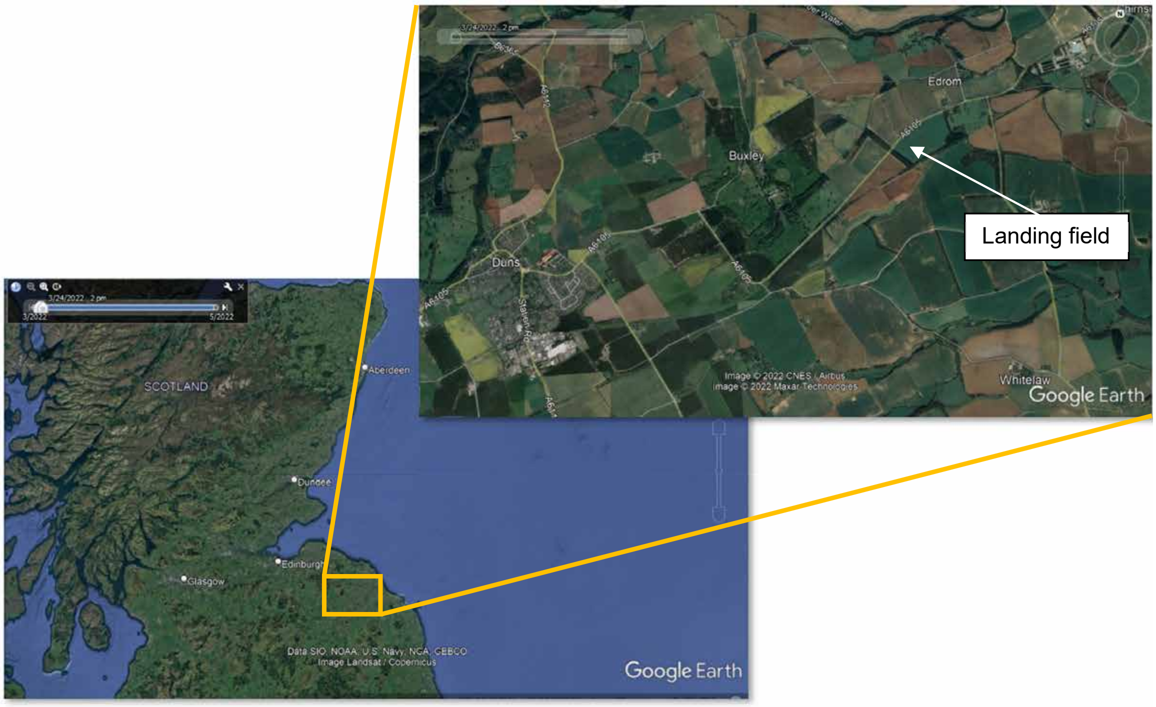


Figure 1

Location of precautionary landing field

Both pilots walked the field to assess its condition and decided that it was unsuitable and that it would be unsafe to attempt a takeoff. The northern side of the field is bounded by the A6105 road, with further fields beyond, and the pilot stated that the only clear area available for him to use for takeoff was the road, running in a south-westerly direction. He paced out approximately 700 m of straight road that he believed was suitable for the takeoff run. He reported that the straight section of the road was longer than the distance required for takeoff with reference to the AFM. The road surface was smooth, with a dashed white centre line, and was lined on both sides by hedges with a gap between them that he judged to be sufficient. He concluded that the road would be a safer takeoff surface than the field. The weather was CAVOK with a wind from 310° at less than 10 kt. A number of local residents, who had arrived to assist the pilot, were sent to close the road to traffic.

At approximately 1100 hrs the pilot positioned his aircraft on the road and commenced his takeoff run, applying full power and with one stage of takeoff flap selected. Just as he reached takeoff speed and started to rotate, he stated that “a strong gust of wind” blew the aircraft to the left. He attempted to counter this with right rudder and aileron inputs, but the right wing tip contacted the road surface and yawed the aircraft to the right. He then felt the left wing tip strike the hedge on the left side of the road causing the aircraft to rotate through 180° and come to rest on top of the hedge facing northeast. The pilot sustained minor injuries but was able to shut down and egress the aircraft. The police arrived shortly afterwards having been flagged down by a member of the public reporting an aircraft crashed by the side of the road.

The pilot had not contacted Scottish Borders Council or Police Scotland to seek permission and assistance to use the public road as a makeshift runway. He informed the AAIB that he had felt a sense of urgency to return the aircraft to the operator as it was due to be used for revenue flights, and he was concerned about its security as it was in clear sight from the road.

The A6105

The A6105 connects the village of Earlston to Berwick-upon-Tweed, passing through Duns. It is single carriageway and the police reported that it is often busy with local traffic. For road and obstacle dimensions see Figure 2.

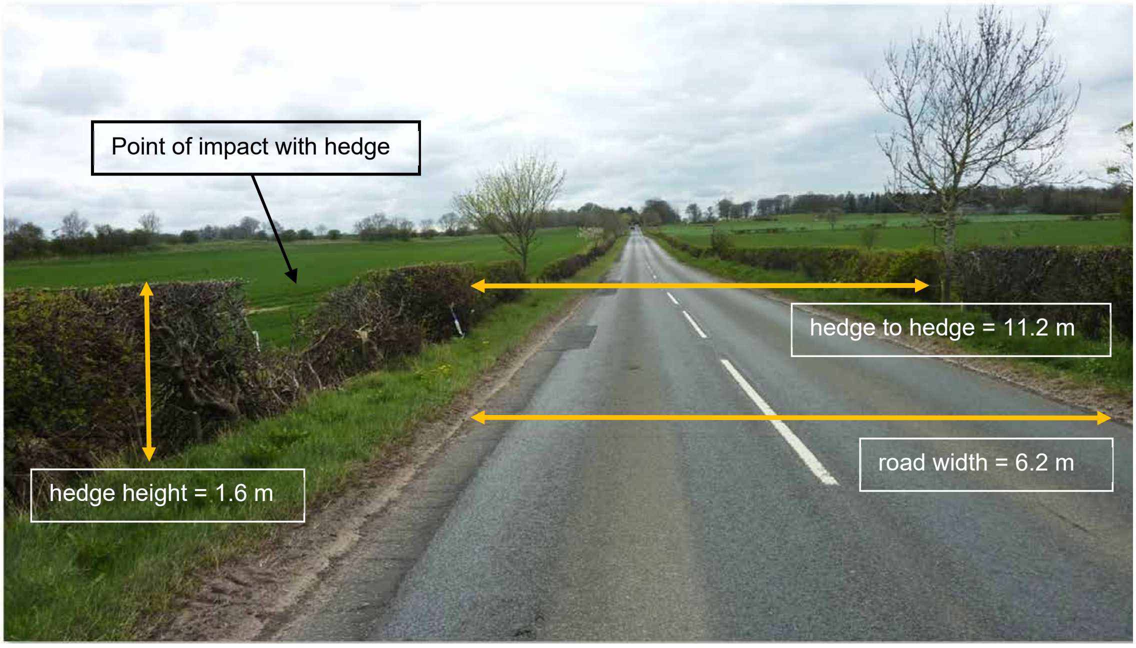


Figure 2

A6105 looking south-west towards Duns along the takeoff path
(image used with permission)

The A6105 is administered by the Scottish Borders Council who informed the AAIB that in order to use the public road as a runway, the pilot would need to formally request permission with sufficient notice to allow proper consideration of the merits of the request and input from all relevant stakeholders. However, they added that they would not expect access to the road network to be granted other than in "extreme circumstances", in which case the police would be required to close the road and establish a suitable diversion for traffic to ensure safety. The Council confirmed that they had not received such a request from the pilot.

Aircraft wing dimensions

The EV-97 Teameurostar UK has a wingspan of 8.1 m giving a clearance on each wing tip of 1.55 m from the hedges at the side of the road.

Regulations and guidance material

Air Navigation Order (ANO)

The ANO states that the pilot in command is responsible for '*the operation and safety of the aircraft*', and '*must only use aerodromes and operating sites that are adequate for the type of aircraft and operation concerned*'. Additionally, before commencing a flight, the pilot in command '*must be satisfied that the flight can be made safely*' and ensure that '*procedures are established and followed for any reasonably foreseeable emergency situation*'.

Civil Air Publication (CAP) 793 (2010): Safe Operating Practices at Unlicensed Aerodromes

CAP 793 provides guidance to the owners of, and those who fly from, unlicensed aerodromes and sites to enable safe operating practices to be met. The recommended minimum runway dimensions are:

- Microlight (< 450 kg MTOM): runway width – 10 m (15 m if within crop above 33 cm high); no vertical obstacles within 25 m either side of the centreline.

CAA Safety Sense Leaflet 12 (2022): Strip Flying

The CAA publishes Safety Sense Leaflet 12: *Strip Flying*, which is intended to assist pilots to think about safety when planning to fly to a strip for the first time, and provides general operational guidance. The leaflet summary contains the following guidance:

> *'When planning a flight to a new strip, consider the following points:*
>
> - ***Permission –** do you have permission to use the strip?*
> - ***Suitability –** have you satisfied yourself it is safe to operate there with your aircraft and flying experience?*
> - ***Skill level –** is your flying accurate enough and are you suitably competent in the steep approach (if applicable) and short field techniques for your aircraft?*
> - ***Planning** – have you planned your approach and departure profiles, including any special manoeuvres or noise abatement procedures?'*

CAP 1535 (2021): Skyway Code

The Skyway Code is intended to provide General Aviation pilots with practical guidance on the operational, safety and regulatory issues relevant to their flying. It states that:

> *'Good decision making is one of the first lines of defence against risk since it allows for risks to be avoided or mitigated, rather than relying purely on skill or luck to manage them.'*

To assist the decision-making process, the 'PAVE' checklist is suggested as a thematic way to assess risk as part of the pre-flight check process:

- *'**P**ilot – things like currency, fitness.*
- ***A**ircraft – airworthiness, capabilities, limitations.*
- *En**V**ironment – weather, facilities, terrain, airspace.*
- ***E**xternal pressures – time pressure, delays, passengers.'*

Additionally, to inform the threat and error management (TEM) process, the Skyway Code offers the following guidance on decision making:

- *'Adopt a cautious attitude to decision making, always checking information and carefully considering the different factors.*
- *Adopt a risk-based approach – identify risks such as weather or lack of currency. If you identify a number of risks on a particular flight, question whether it is sensible to proceed. Consider modifying your plans to reduce some of the risk factors.*
- *Always ask the 'what if?' question.*
- *Avoid exposing yourself to pressure to complete a flight.'*

Analysis

The accident occurred because the pilot was unable to maintain sufficient directional control of the aircraft during the takeoff to prevent the left wing colliding with the hedge. The pilot believed this was because of an unexpected gust of wind. The hedges were 1.6 m high and the clearance on each wing tip was 1.55 m. Both the width of the road and the distance between the hedges lining the road were significantly less than the minimum dimensions recommended by the CAA in CAP 793: that the runway width should be 10 m and that there should be no vertical obstructions within 25 m of the centreline.

The ANO is clear that the pilot in command '*must only use aerodromes and operating sites that are adequate for the type of aircraft and operation concerned'*. The A6105 was not adequate for use as an aircraft operating site.

The ANO is also clear that before commencing a flight the pilot in command '*must be satisfied that the flight can be made safely*' and ensure that '*procedures are established and followed for any reasonably foreseeable emergency situation*'. By not seeking the permission of the Scottish Borders Council and the input of relevant stakeholders in the operation, maintenance and safety of the A6105, the pilot could not assess the wider safety implications of his planned course of action and the risks that might present to third parties.

The CAA provides considerable guidance for GA pilots to assist in good decision making. A sound working knowledge of this material is an essential part of the TEM process of recognition and avoidance of potential threats in the first instance. The pilot made a sound decision in making a precautionary landing when he encountered weather conditions unsuitable for VFR flight. However, when he returned to the landing site and found the situation was not as he expected, had the regulations and guidance been considered, it is probable that this accident would have been avoided.

ACCIDENT

Aircraft Type and Registration:	MA Scale F4 Phantom
No & Type of Engines:	1 Turbine engine
Year of Manufacture:	2021 (Serial no: N/A)
Date & Time (UTC):	16 September 2021 at 1430 hrs
Location:	Near Kenyon Hall Farm Airfield, Warrington, Cheshire
Type of Flight:	Private
Persons on Board:	Crew - N/A Passengers - N/A
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Destroyed
Commander's Licence:	Other
Commander's Age:	72 years
Commander's Flying Experience:	Unknown hours (of which unknown were on type) Last 90 days - unknown hours Last 28 days - unknown hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further AAIB enquiries

Synopsis

A turbine powered model aircraft suffered a loss of control during its maiden test flight. It continued to fly beyond visual line of sight before crashing on a railway track and was subsequently run over by a passing train. Safety actions taken as a result of this accident include publication of enhanced guidance for members by the British Model Flying Association (BMFA). The model flying club also amended its procedures relating to flying turbine powered models.

History of the flight

The F4 Scale Phantom is a 1:10 scale flying model of the McDonnel Douglas F4 Phantom jet aircraft. It has a takeoff mass of 6.4 kg and is powered by a turbine engine using kerosene.

The recently-built model aircraft was undergoing its first test flight. Pre-flight preparation had included an independent check of the control surface sense and deflections, as well as range checks between the transmitter (on the controller) and the receiver (on the aircraft), from multiple angles.

A normal takeoff was performed to a height of approximately 200 ft agl, for a flight that predominantly comprised of left hand 'race-track circuits.' During the flight the pilot noted that the aileron response was "sluggish", but he considered it sufficient for safe flight. He subsequently noted that up elevator was required to maintain level flight and progressively applied 'up' trim. During a 180º downwind turn, the aircraft suddenly veered to the right putting it on a north-west heading. Despite the pilot applying corrective aileron inputs, the aircraft did not respond and control was lost. It subsequently stalled, entered a spin and disappeared out of visual line of sight below a tree line.

The model aircraft was later found to have come to rest on a railway track adjacent to the airfield, close to a pedestrian crossing, and was subsequently run over by a passing train. The wreckage was recovered by the pilot and other club members. There were no injuries or damage to property. The model aircraft was destroyed.

The pilot considered that he had let the airspeed drop too low while concentrating on applying corrective elevator trim.

Airfield information

The model flying club is based at Kenyon Hall Farm Airstrip (Figure 1), which is an unlicensed airfield with a grass Runway 05/23 for full size aircraft. There are two runways for model flying, a 75 m strip adjacent and parallel to 05/23 and a 110 m strip, which runs in an east-west direction. A railway track passes to the north of the site. There are several public footpaths which run along the north-west boundary of the airfield, and in the area between the airfield and railway track.

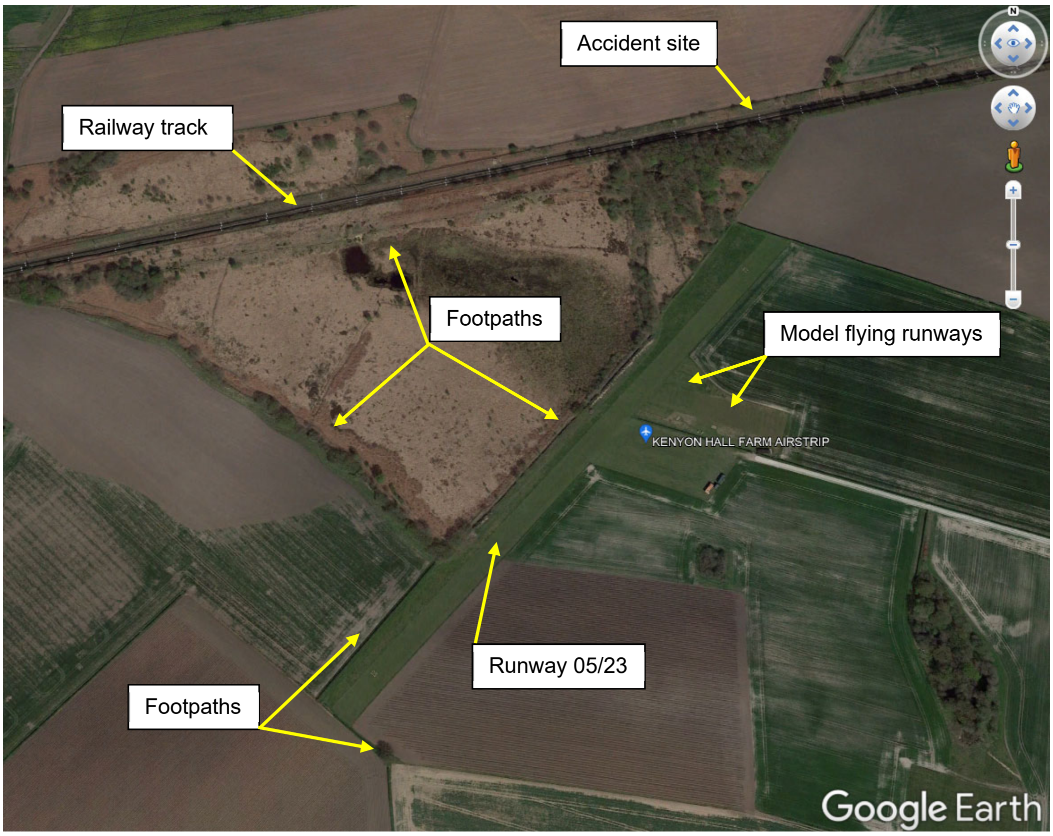


Figure 1

Airfield overview

Organisational information

The model flying club was affiliated with the BMFA. The club procedures contained an airfield diagram depicting the approved overfly zone (Figure 2) and advised that members should *'avoid flying at distance'* in the direction of the railway track.

The procedures referred to the various footpaths in the vicinity of the airfield. Regarding the footpath on the edge of Runway 05/23, they stated that pedestrians using this path can be easily seen from the pilot's box and takeoff or landing should be avoided when people are in this area. Another footpath on the south of the site is obscured by a hedge, and the procedures stated that flying over this area should be avoided. Neither the footpaths in the wooded area between the airfield and the railway track nor the pedestrian crossing over the railway track were specifically mentioned in the club procedures.

The procedures did not include any instructions regarding what steps members should take if an aircraft crashed on or near the railway track.

Figure 2

Airfield overfly area from model flying club procedures

The model flying club's risk assessment did not include any hazards specifically relating to operation of model aircraft in the proximity to the railway line or loss of control in proximity to the railway line, although it did include several other loss of control scenarios.

Club safety investigation

Following the accident, the model flying club carried out an internal safety investigation, which determined that preparation for the flight was performed in accordance with club procedures. The investigation did not identify the reason for the loss of control but considered several possibilities.

The club carries out approximately 6,500 flights per year and reported that this was the first aircraft to have crashed on the railway in over seven years of operation. Following the accident, the club amended its procedures to require any turbine powered model to be approved by the club committee before it can be flown at the site so that its suitability can be assessed.

Network Rail guidance for operating unmanned aircraft in the vicinity of railway tracks

Network Rail publishes guidance on its website[1] for operating unmanned aircraft (including model aircraft) in the vicinity of railway tracks. This indicates that unmanned aircraft cannot be flown within 50 m of a Network Rail track without prior permission from its Air Operations team. For recreational or commercial UAV flights, permissions can be applied for via Network Rail's flight management system[2].

Network Rail advised the AAIB that an object the size and weight of the model aircraft on a railway track would be unlikely to cause damage or risk of derailment to a moving train. However, collision with a train, in particular the driver's window, could cause a substantial safety threat, particularly given the carriage of jet fuel in this particular case. It could also represent a risk to track workers or users of the pedestrian crossing.

Discussion

After control of the model aircraft was lost, it continued to fly for a short time beyond visual line of sight. The aircraft crashed on an adjacent railway track and close to a public footpath, where it had the potential to cause injury to uninvolved third persons. While the model aircraft was considered unlikely to have posed a train derailment risk given its size and weight, a train running over a jet-fuel powered model aircraft is a highly undesirable situation. There was also potential risk that the aircraft could have struck the train window.

The club procedures required members to avoid intentionally flying their aircraft in the direction of the railway track, but its risk assessment did not include the hazard of an inflight loss of control resulting in an aircraft crashing beyond visual line of sight, including on or close to the railway. There was consequently no guidance on alerting Network Rail to the potential threat of an object on the track and no guidance to members about the hazards of entering an active railway track.

Safety actions

Following the accident, collaboration was undertaken between the BMFA and Network Rail's Air Operations team. This resulted in the provision of tailored guidance for unmanned and model aircraft operators which will be incorporated in the BMFA's member's handbook. It included the provision of a 24-hour emergency contact telephone number for reporting railway safety threats, including the presence of people or objects on or near railway tracks.

Footnote

1 https://www.networkrail.co.uk/communities/safety-in-the-community/drone-safety-and-the-law/ [accessed August 2022]

2 Hosted on the https://dronecloud.io application.

The BMFA also published an article about this accident, and operation in proximity to railways in general, in the July 2022 edition of its member magazine ‘BMFA news’.

In addition, the BMFA has updated its incident/accident reporting portal to specifically guide members to telephone Network Rail immediately in the event that an aircraft has come down on Network Rail property, in addition to the requirement to inform the AAIB.

After the accident the club amended its procedures to require any turbine powered model to be approved by the club committee before it can be flown at the site, so that its suitability can be assessed. Following this investigation the club added a section to its procedures relating to retrieval of models that land outside the airfield boundary, which directly references the Network Rail 24-hour emergency telephone number.

AAIB Record-Only Investigations

This section provides details of accidents and incidents which were not subject to a Field or full Correspondence Investigation.

They are wholly, or largely, based on information provided by the aircraft commander at the time of reporting and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

Record-only investigations reviewed: July - August 2022

27 Feb 2022 **Eurofox 914** **G-CIBF** The Airfield, Milfield, Northumberland

The pilot had completed nine glider tugs as the 'duty tug pilot' and was returning for his final landing of the day. He reported a wind of 15-18 kt on final approach and conditions which were gustier than his previous approaches that morning. Before touchdown the left wing dropped unexpectedly, causing the left main wheel to touch down abruptly. The nose then dropped and the propeller contacted the ground, stopping the aircraft suddenly and causing significant damage.

1 Mar 2022 **Ikarus C42 FB UK** **G-CDCO** Peterlee Airfield, County Durham

The aircraft veered off the runway during landing, damaging the landing gear and fuselage.

16 May 2022 **Guimbal Cabri G2** **G-TOOO** Houghton on the Hill, Leicester

Whilst on a training flight the left engine cowl opened and was severed by the main rotor. The commander reported no handling difficulties and a precautionary landing was carried out without further incident.

27 May 2022 **Aeroprakt A22 Foxbat** **G-CBYH** Popham Airfield, Hampshire

The aircraft landed heavily, resulting in the nose landing gear collapsing rearward and the propellor striking the ground.

1 Jun 2022 **Groppo Trail Mk 2** **G-SMLZ** Old Warden Airfield, Bedfordshire

The aircraft experienced a violent swing to the right after touchdown, so the pilot applied full power and aborted the landing. The aircraft pitched up steeply, the left wing then dropped and struck the ground. The aircraft rotated onto its right wing and came to rest on its right side. The pilot reflected that an unexpectedly strong gust of wind likely caused the initial swing on touchdown. He was surprised by the rapidity of the pitch up.

2 Jun 2022 **Cessna F150H** **G-AWOT** Eshott Airfield, Northumberland

The student pilot was completing a solo cross country flight. The aircraft landed long, ran off the end of the runway and struck a fence. The pilot reported that fatigue might have been a factor. The aircraft suffered damage to the propeller, shock-loading of engine and slight damage to the left landing gear leg.

12 Jun 2022 **Piper PA-28-180** **G-GBRB** Near Netherthorpe Airfield, Nottinghamshire

Shortly after takeoff the relatively heavy aircraft encountered turbulent air. The pilot reported that he lowered the nose to maintain airspeed, and descended and landed in a nearby field. The aircraft was substantially damaged.

Record-only investigations reviewed: July - August 2022 cont

21 Jun 2022 **Piper PA-28-180** **G-RVNX** Liverpool Airport

After being slightly high on the approach, the aircraft touched down firmly and bounced. It initially veered to the left, before departing to the right of the runway and the nose landing gear collapsed. The pilot considered that the approach could have been more stable and that he may have over-corrected when the aircraft veered left after touchdown.

23 Jun 2022 **Sherwood Scout** **G-OUAV** Popham Airfield, Hampshire

The pilot struggled to maintain a stable approach and during the subsequent go-around the left landing gear leg struck the ground heavily and the gear leg detached. The pilot has now ceased flying the aircraft which he found difficult to handle during landing.

26 Jun 2022 **Robinson R44 II** **G-CIMZ** Chalvington, East Sussex

The helicopter rolled over to the right on takeoff, probably because it had drifted right while the right skid was in contact with the ground. The helicopter was substantially damaged.

27 Jun 2022 **EC155 B1** **G-HCNX** Sandown Airport, Isle of Wight

As G-HCNX hover taxied to a pre-agreed parking location, its downwash lifted the right wing of a Cessna 172 parked approximately 30 m downwind. The Cessna's left wing struck the ground, causing a visible crease in its outboard leading edge. The helicopter pilot stated that greater consideration could have been given to the prevailing wind when parking.

9 Jul 2022 **Vans RV-6A** **G-RVEE** Eshott Airfield, Northumberland

The pilot reported that he flared early and the subsequent heavy contact with the runway caused the nose gear strut to deform. The aircraft then veered off the side of the runway into long grass and tipped over. The pilot stated that he was distracted by a fence and lack of chevron marking at the runway threshold which contributed to his early flare.

10 Jul 2022 **DA 40** **G-SFLY** Oaksey Park Airfield, Wiltshire

Just after touch down, the aircraft bounced, so the pilot attempted to initiate a go-around and applied full power. The aircraft rapidly veered right towards a line of trees. The pilot was unable to react in time before the aircraft collided with the trees, and eventually came to a stop as it struck a nearby hangar. The aircraft was severely damaged.

Record-only investigations reviewed: July - August 2022 cont

10 Jul 2022 **Groppo Trail** **G-TRLL** Sleap Airfield, Shropshire

During a landing on Runway 36 in benign weather conditions, the aircraft "swung violently left" on touchdown. The pilot tried to correct, but the aircraft swung right and then left, and tipped onto its nose as it came to a halt. The pilot stated that the approach and flare were normal, and he was unable to explain the cause of the loss of control as no issues were found during a subsequent inspection of the aircraft.

11 Jul 2022 **DHC-1 Chipmunk 22 (Lycoming)** **G-BBSS** Husbands Bosworth Airfield, Leicestershire

After completing an aerotow flight, the aircraft was being taxied through a 20 m gap between a set of wing trestles and a glider trailer when the aircraft's right wingtip struck the trailer. The pilot considered that his angle of approach to the gap left him only partially sighted on the trailer and his attention had been primarily focused on avoiding the trestles. He reflected that the incident might have been avoided if he had taxied more slowly and weaved in a more exaggerated manner to improve forward visibility.

16 Jul 2022 **Pulsar** **G-LWNG** Carlisle Airport

The pilot misjudged the final approach due to a problem with the throttle and the aircraft landed heavily on its nose landing gear which collapsed.

16 Jul 2022 **Jodel D117A** **G-AYXP** Lane Farm Airfield, Powys

During the landing rollout, some deer crossed the aircraft's path. In steering to avoid them the right wing of the aircraft struck a fence which spun the aircraft round resulting in damage to both wings and the landing gear.

18 Jul 2022 **Aero AT-3 R100** **G-SBRK** Gloucestershire Airport

During the final approach the aircraft began to oscillate in pitch. On touchdown the nose landing gear collapsed and the aircraft slewed to the left side of the runway.

21 Jul 2022 **Beech C23** **G-BASN** Compton Abbas Airfield, Dorset

The pilot was flying his third approach to Runway 08, having gone around on the two previous approaches due to being too high and fast. He reported being a little high on the third approach, and bounced on landing causing the nose landing gear to detach.

Record-only investigations reviewed: July - August 2022 cont

23 Jul 2022 **Pegasus Quantum 15-912** **G-CCWW** Caunton Airfield, Nottinghamshire

On landing the flexwing microlight left the side of the runway and sustained damage.

28 Jul 2022 **Rearwin 8125 Cloudster** **G-EVLE** RAF Marham, Norfolk

On touchdown in a moderate crosswind the pilot was unable to control a significant right yaw with full left rudder. When he also applied left brake the aircraft pitched over onto its back. The pilot found it challenging to apply the heel-operated disc brakes with full rudder. During recovery the brake was found seized and had probably caused the accident.
Note: The final sentence of this report was added prior to publication. This was reflected online at publication and as an addendum in the November Bulletin.

28 Jul 2022 **Mainair Blade** **G-RINN** Headon, Nottinghamshire

The aircraft lost airspeed during the final stages of the approach and landed heavily, bending the front strut and keel.

5 Aug 2022 **Cessna 152** **G-BNSN** Denham Aerodrome, Buckinghamshire

Whilst taxiing, the aircraft's right landing gear collapsed.

7 Aug 2022 **Wittman W8 Tailwind** **G-ZIPY** Bolt Head Airfield, Devon

During the final stages of the approach to a coastal farm strip, the aircraft experienced sink, possibly due to windshear. The pilot applied power but was unable to arrest the rate of descent and the underside of the aircraft struck a fence near the runway threshold. This caused the aircraft to tip forward and it skidded along the runway on the propeller spinner and main landing gear. Given the proximity of the fence to the threshold, the pilot considered that, aiming to touchdown on the runway numbers had reduced his options when he encountered sink during the approach.

8 Aug 2022 **Jabiru UL** **G-BYJD** Carlisle Airport, Cumbria

After landing, and at a speed of 20-30 kt, the aircraft began to shimmy and it departed the runway onto the grass. The propeller, nose gear and wing were damaged.

8 Aug 2022 **Sherwood Scout** **G-CLAK** Membury Airfield, Berkshire

The aircraft suffered a hard landing which resulted in the nose landing gear collapsing and damage to the right main landing gear and propeller.

Record-only investigations reviewed: July - August 2022 cont

10 Aug 2022 **Guimbal Cabri G2** **G-SDTL** Goodwood Aerodrome, West Sussex

Having completed a circuit with an instructor, the student was to complete his second solo flight in the helicopter. He lifted into the hover and began a pedal turn to the left during which a rapid rate of yaw to the left developed. The helicopter completed two complete 360° turns before striking the ground on its right side causing significant damage to the helicopter.

13 Aug 2022 **Skyranger 912(2)** **G-CCEH** Cae Mawr Airfield, Gwynedd

The pilot was making his approach to Runway 03. As he reduced power to land, the aircraft suddenly dropped and clipped a hedge which caused the aircraft to land heavily. The pilot suspected that he had experienced windshear.

13 Aug 2022 **EV-97 Eurostar Microlight** **G-CJJA** Eshott Airfield, Northumberland

The pilot lost control of the aircraft under "hard" braking after landing long in light wind. The aircraft turned right and exited the runway, coming to rest after it struck the airfield boundary fence and hedge. The pilot stated that "subconsciously I was probably too keen to do a successful landing" and in hindsight should have gone around.

19 Aug 2022 **Cessna F172M** **G-OAFA** Middle Wallop Airfield, Hampshire

The student pilot was flying solo. On landing the aircraft bounced twice and on the third touchdown the nosewheel broke away. The propeller was damaged when it struck the ground and the left wing spar was bent when the the wing touched the ground.

19 Aug 2022 **Z-526F Trener** **OE-CSA** Breighton Airfield, East Riding of Yorkshire

After landing, and while taxiing to the park area, the pilot reported that he lost directional control of his aircraft and struck an unoccupied parked aircraft causing substantial damage to both aircraft.

24 Aug 2022 **Piper PA-28-180** **G-HRYZ** Great Oakley Airfield, Essex

The aircraft bounced three times during the landing and the nose gear, together with the propeller and engine mounts, sustained damage.

28 Aug 2022 **Piper PA-28-161** **G-CDDG** Compton Abbas Airfield, Dorset

G-CDDG was being ground-manoeuvred by the pilot using a handling bar when the wing contacted and damaged the rudder of an unoccupied aircraft.

Record-only investigations reviewed: July - August 2022 cont

31 Aug 2022	**Rotorsport UK MTOsport**	**G-CJTA**	Rufforth Airfield, North Yorkshire
	The aircraft suffered a suspected bird strike during takeoff which resulted in a loss of control, a tail strike and then a heavy landing on the nosewheel. The aircraft suffered substantial damage.		

Miscellaneous

This section contains Addenda, Corrections and a list of the ten most recent Aircraft Accident ('Formal') Reports published by the AAIB.

The complete reports can be downloaded from the AAIB website (www.aaib.gov.uk).

BULLETIN CORRECTION

Aircraft Type and Registration:	Boeing 737-8K5, G-TAWY
Date & Time (UTC):	9 March 2022 at 0840 hrs
Location:	Manchester Airport
Information Source:	Aircraft Accident Report Form submitted by the commander and further enquiries by the AAIB

AAIB Bulletin No 08/2022, page 117 refers

The following sections of the report were amended post-publication:

Operator's comments (first paragraph, last sentence)

Original text:

> The operator considered this was more than required by the regulations.

The sentence is deleted.

Operator's comments (third paragraph, first sentence)

Original text:

> The operator is aware that training low experience pilots in a long body aircraft like the B737-800 poses a tail strike risk and has this risk on its risk register.

Corrected text:

> The operator is aware that training pilots in a long body aircraft like the B737-800 poses a tail strike risk and has this risk on its risk register.

The online version of this report was corrected when published on 11 August 2022.

TEN MOST RECENTLY PUBLISHED FORMAL REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

1/2015 Airbus A319-131, G-EUOE
London Heathrow Airport
on 24 May 2013.

Published July 2015.

2/2015 Boeing B787-8, ET-AOP
London Heathrow Airport
on 12 July 2013.

Published August 2015.

3/2015 Eurocopter (Deutschland) EC135 T2+, G-SPAO
Glasgow City Centre, Scotland
on 29 November 2013.

Published October 2015.

1/2016 AS332 L2 Super Puma, G-WNSB
on approach to Sumburgh Airport
on 23 August 2013.

Published March 2016.

2/2016 Saab 2000, G-LGNO
approximately 7 nm east of Sumburgh Airport, Shetland
on 15 December 2014.

Published September 2016.

1/2017 Hawker Hunter T7, G-BXFI
near Shoreham Airport
on 22 August 2015.

Published March 2017.

1/2018 Sikorsky S-92A, G-WNSR
West Franklin wellhead platform, North Sea
on 28 December 2016.

Published March 2018.

2/2018 Boeing 737-86J, C-FWGH
Belfast International Airport
on 21 July 2017.

Published November 2018.

1/2020 Piper PA-46-310P Malibu, N264DB
22 nm north-north-west of Guernsey
on 21 January 2019.

Published March 2020.

1/2021 Airbus A321-211, G-POWN
London Gatwick Airport
on 26 February 2020.

Published May 2021.

Unabridged versions of all AAIB Formal Reports, published back to and including 1971, are available in full on the AAIB Website

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilot's Licence
BMAA	British Microlight Aircraft Association
BGA	British Gliding Association
BBAC	British Balloon and Airship Club
BHPA	British Hang Gliding & Paragliding Association
CAA	Civil Aviation Authority
CAVOK	Ceiling And Visibility OK (for VFR flight)
CAS	calibrated airspeed
cc	cubic centimetres
CG	Centre of Gravity
cm	centimetre(s)
CPL	Commercial Pilot's Licence
°C,F,M,T	Celsius, Fahrenheit, magnetic, true
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Union Aviation Safety Agency
ECAM	Electronic Centralised Aircraft Monitoring
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FAA	Federal Aviation Administration (USA)
FDR	Flight Data Recorder
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
hrs	hours (clock time as in 1200 hrs)
HP	high pressure
hPa	hectopascal (equivalent unit to mb)
IAS	indicated airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IP	Intermediate Pressure
IR	Instrument Rating
ISA	International Standard Atmosphere
kg	kilogram(s)
KCAS	knots calibrated airspeed
KIAS	knots indicated airspeed
KTAS	knots true airspeed
km	kilometre(s)
kt	knot(s)
lb	pound(s)
LP	low pressure
LAA	Light Aircraft Association
LDA	Landing Distance Available
LPC	Licence Proficiency Check
m	metre(s)
mb	millibar(s)
MDA	Minimum Descent Altitude
METAR	a timed aerodrome meteorological report
min	minutes
mm	millimetre(s)
mph	miles per hour
MTWA	Maximum Total Weight Authorised
N	Newtons
N_R	Main rotor rotation speed (rotorcraft)
N_g	Gas generator rotation speed (rotorcraft)
N_1	engine fan or LP compressor speed
NDB	Non-Directional radio Beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
OAT	Outside Air Temperature
OPC	Operator Proficiency Check
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PIC	Pilot in Command
PM	Pilot Monitoring
POH	Pilot's Operating Handbook
PPL	Private Pilot's Licence
psi	pounds per square inch
QFE	altimeter pressure setting to indicate height above aerodrome
QNH	altimeter pressure setting to indicate elevation amsl
RA	Resolution Advisory
RFFS	Rescue and Fire Fighting Service
rpm	revolutions per minute
RTF	radiotelephony
RVR	Runway Visual Range
SAR	Search and Rescue
SB	Service Bulletin
SSR	Secondary Surveillance Radar
TA	Traffic Advisory
TAF	Terminal Aerodrome Forecast
TAS	true airspeed
TAWS	Terrain Awareness and Warning System
TCAS	Traffic Collision Avoidance System
TODA	Takeoff Distance Available
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
USG	US gallons
UTC	Co-ordinated Universal Time (GMT)
V	Volt(s)
V_1	Takeoff decision speed
V_2	Takeoff safety speed
V_R	Rotation speed
V_{REF}	Reference airspeed (approach)
V_{NE}	Never Exceed airspeed
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional radio Range

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